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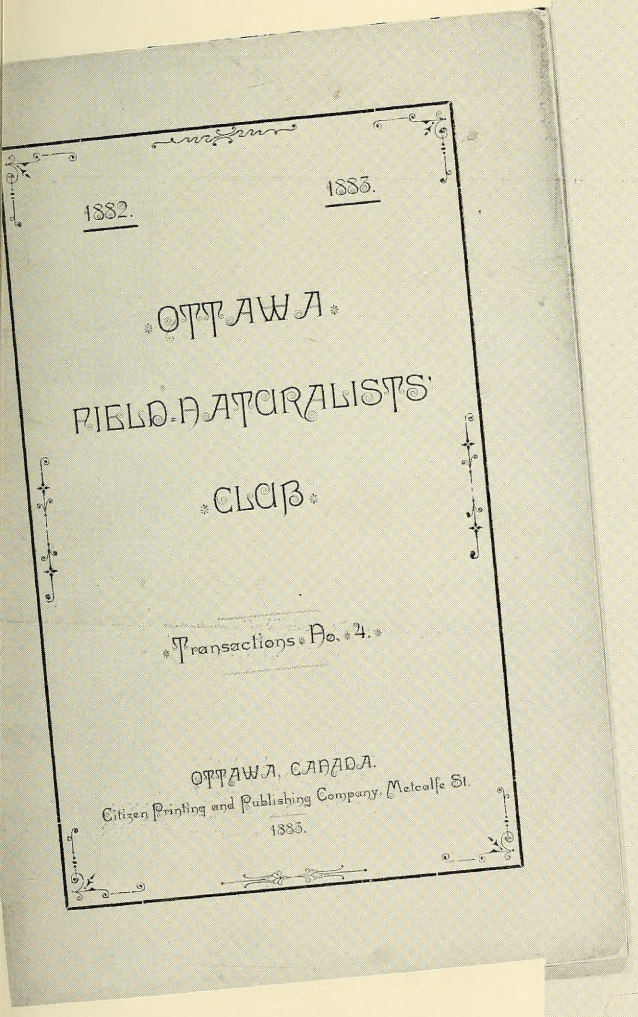
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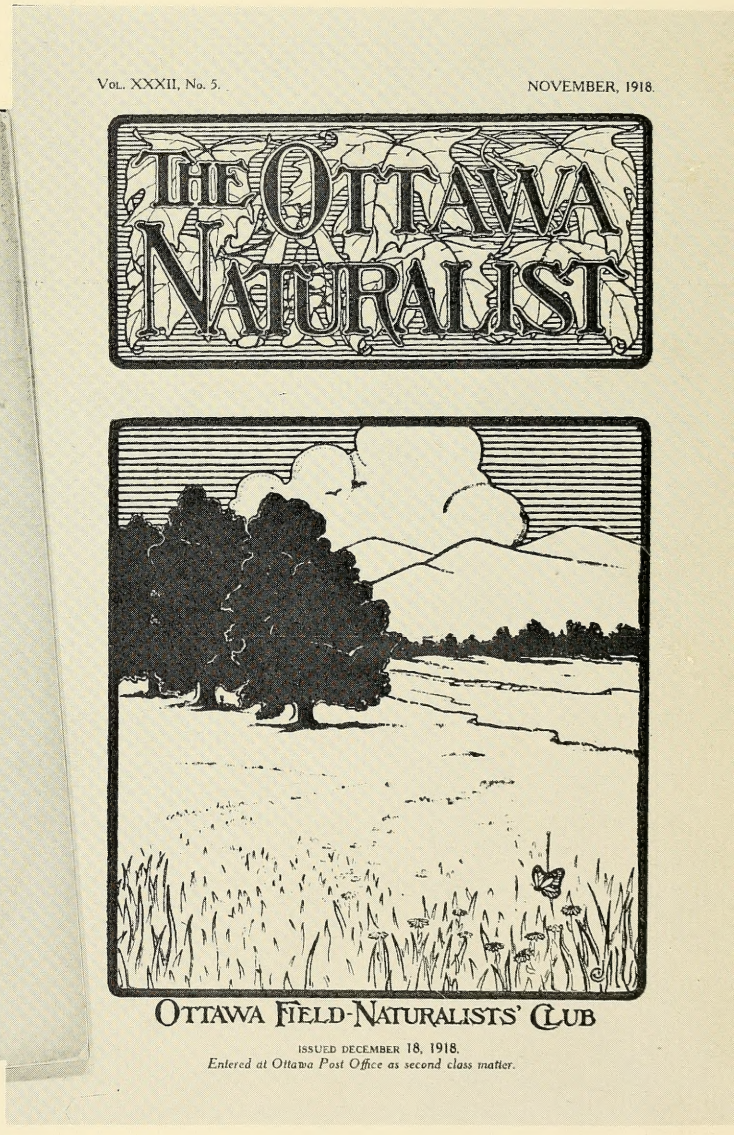
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Volume 93, Number 1 **January-March 1979**

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Madame Jules Léger

The objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and cooperate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

The Members of Council are listed on the inside back cover.

The Canadian Field-Naturalist

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Cover: Since the Club was founded in 1879, it has published a journal under three successive names. Covers bearing the two names preceding the present one are illustrated. Left, *Ottawa Field-Naturalists' Club, Transactions,* published for 1879 to 1886. Right, *The Ottawa Naturalist,* published from 1887 to 1919; it bore this cover design only between April 1918 and March 1919.

THE CANADIAN FIELD-NATURALIST

Volume 93

1979

CENTENNIAL YEAR
THE OTTAWA FIELD-NATURALISTS' CLUB

OTTAWA CANADA

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The Canadian Field-Naturalist

Volume 93, Number 1 January-March 1979

One Hundred Years in Perspective — the Changing Roles and Objectives of The Ottawa Field-Naturalists' Club

ROGER A. FOXALL

President, The Ottawa Field-Naturalists' Club, January 1977–January 1979

Following an invitation to members of the Ottawa Literary and Scientific Society, "fully forty gentlemen attended the meeting held on the 19th March, 1879. After a lengthy discussion as to the form the organization should take, the Ottawa Field-Naturalists' Club was born."

The quotation above is from the first historical sketch of the Club, taken from the 1880 Annual Report when the Club was fully one year old. Since then there have been several articles describing the many memorable people and events that add up to the varied and fascinating 100-year history of our Club. A series of historical articles is currently being published in *Trail & Landscape*. The aim of this message is not to provide another summary of people or events, but to review instead the ways in which the Club's functional role and objectives have changed over time and to present a personal view of our present role and objectives in terms of future needs.

In the beginning, the objective of the Club was stated simply as "the study of the Natural History of this locality." The raison d'être, however, was more explicit in an 1884 summary:

> "The value of these studies cannot be over-estimated for, from their very nature, they are most beneficial both to mind and body, while, from an economical point of view they are no less important . . . . The future of Ottawa is in large measure dependent upon the development of the vast stores of minerals contained in the surrounding districts, and which are as yet almost unexplored. The manifold uses and demand for all vegetable products make it necessary that the nature and habits of plants should be closely studied, as well as those of the countless myriads of insect foes which deprive the cultivator of so much of his hard-earned gains . . . . It gives very great satisfaction to the members of the Council to find that the Club is being gradually recognized as a source of reliable reference on all these matters."

So the objective in part was the study of natural history to assist the economical development of the Ottawa area. Times have indeed changed! A specific example of success in this direction was the advice given to the Ottawa Granite Company that within a few miles of the city there existed an outcrop of quartzite deposits just as good as quartzite then being imported from New York State. This advice led to successful commercial exploitation of the deposits.

Although economic development of the Ottawa area was one aim of the Club, another was to popularize the study of the different branches of natural history and thereby increase appreciation of nature. On the local scene this entailed programs of organized studies, excursions, lectures, and generally spreading the good word. By the thirtieth anniversary, Club membership had increased from the initial 40 to over 300. Increasingly, however, the Club's successes led to recognition throughout the Dominion, and its role began to broaden from that of a strictly local club towards

that of a national society. In an 1893 *The Ottawa Naturalist,* the editor found it necessary to state, "Although the scope of the Club's work has been gradually widened to receive the benefits of investigations made by its members wherever they may be located, the special work for which it was organized must still merit the chief attention, and although much has been observed and recorded of the Natural History of Ottawa, there still remains vastly more to be done." But the transformation accelerated! A series of 42 nature study articles was written for *The Ottawa Naturalist* by leading Club members, and between 1903 and 1908 a total of 238000 separate copies was distributed to schools and colleges across Canada. Such was the success and expanding influence of the Club that Ottawa's *Evening Journal* (although perhaps a little biased) found it appropriate in 1908 to state that "today The Ottawa Field-Naturalists' Club is the greatest institution of the kind in the entire continent of North America."

Partly because of the Club's campaigns and the travels of Club members, but mainly because of a general increasing interest in nature, similar organizations were established in several cities across Canada. Increasingly, the need developed for a publication covering the natural history of all of the Dominion, until in 1918 the Foreword to the last volume (32) of *The Ottawa Naturalist* announced:

> "The time has come, however, when a local periodical of this nature is inadequate and the Dominion requires a more creditable and representative publication for the record and dissemination of the results of scientific research. The Ottawa-Naturalist, with its already established position, long and honorable history and scientific standing, seems a logical nucleus from which such a publication should be developed."

The first issue of *The Canadian Field-Naturalist* was published in April 1919. This event in the Club's 40th year marked the end of a lengthy transition and formalized the dual role of the Club — a local natural history club and a national society. Somewhat earlier, in October 1912, the objectives of the Club had been expanded significantly to reflect the two roles:

> To foster an acquaintance with and a love for nature; to study especially the natural history of the Ottawa District; to encourage investigation and to publish the results of original research in all departments of natural history; to arrange for out-of-door excursions during the summer months; to provide free lecture courses during the winter months; and in a general way to render assistance to students or others interested in Nature Study.

With one significant exception, to which I will refer below, these objectives remained unchanged until 1972.

Unfortunately the success of the Club's first 40 years was to be followed by a 30-year period during which many difficulties were encountered. Until about 1923, the Club received a grant from the Ontario Department of Education that contributed significantly to the sustenance of *The Ottawa Naturalist* and later *The Canadian Field-Naturalist.* Ironically, post-war economies led to cancellation of the grant when it was needed most, for the creation of *The Canadian Field-Naturalist* placed a significant burden of responsibility on the Club and all its members. Without the grant, many more members were needed to provide financial stability. But the growth was too slow. In 1934 P. A. Taverner, Chairman of a Special Committee on Membership, issued an appeal to all Canadian naturalists to boost membership. A reduction in size, from 24 to 16 pages an issue, and other parsimonious economies had been tried, but still the year-end balance was negative. The journal survived, of course, but for many years the fight for *The Canadian Field-Naturalist*'s survival represented the principal objective of The Ottawa Field-Naturalists' Club.

The difficulties in maintaining the national role were paralleled by difficulties with the local role. Here, analysis is more difficult. We can perhaps rationalize the decreasing enthusiasm in terms of two gradual developments. The early years of systematic, detailed studies of local natural history must have represented a frontier-like challenge — new knowledge was easily acquired and each discovery, be it a new species of plant, insect, bird, or butterfly, contributed to the developing picture. But the acquisition of new knowledge makes further discoveries just that much more difficult. Members would have to travel further and look harder, and greater expertise was needed. But why

try so hard? The initial objective, to assist in the economic development of Ottawa, was surely less important now. The urgency of acquiring knowledge in support of conservation and preservation to slow down development was not yet recognized. For whatever reasons, it is a fact that emphasis on studying the local natural history declined to the point that in 1947, the objective "to study especially the natural history of the Ottawa District" was removed from the Constitution. Although excursions and lecture programs continued to foster and sustain members' interests in local natural history, the membership grew slowly and even declined for several years.

In retrospect it seems likely that the Club's surviving the difficult 30 years can be attributed to its dual role. For without the local membership, *The Canadian Field-Naturalist* might have failed financially, and without the responsibility of continuing *The Canadian Field-Naturalist,* the local club might have failed for lack of sufficient motivation.

The last 30 years, 1949–1979, have also been characterized by significant changes, but the story is a happier one. *The Canadian Field-Naturalist* has steadily developed into a scientific journal of both national and international repute — a journal almost unique in the world for its breadth and standard of scientific natural history reporting. The content has evolved also. The studies reported have progressively become more sophisticated as new knowledge requires increasingly more detailed examination of natural phenomena. Other, less formal journals and club magazines are now published and these provide media for reporting studies and findings of more local importance. There is no doubt that these evolutions have resulted in *The Canadian Field-Naturalist* becoming of lesser interest to many local members. But the need for *The Canadian Field-Naturalist* is at least as great today as it was in 1919, and, through its continuing support, The Ottawa Field-Naturalist's Club is playing a very valuable role in the reporting of Canadian natural history.

The continuing decrease of Ottawan content in *The Canadian Field-Naturalist* and the need to regenerate the local Club, led to the start, in 1949, of a Club Newsletter for local members. Steadily the pendulum swung back as successive Presidents and Councils worked very hard to rebuild. It was not easy, as illustrated by the anguished appeals in the Newsletter of Chairmen of Excursions and Lectures urging members to attend the many walks and talks that were being arranged. But the rebuilding succeeded and by the late 1960s the local Club had regained much of the status and drive of the early period. As a Canadian Centennial project, the Club upgraded the Newsletter to become the magazine *Trail & Landscape.* For the last eleven years, the staff of *Trail & Landscape* has succeeded in producing an excellent, informative magazine that focusses on local sightings, events, and issues. Sometimes serious, sometimes lighthearted, but always highly readable, *Trail & Landscape* plays an important role in generating and maintaining the enthusiasm of local members.

Somewhat surprisingly, in retrospect, natural history organizations throughout North America were slow to recognize that man's rapid development and exploitation represented a serious threat to all natural environments and living things. In the beginning, The Ottawa Field-Naturalists' Club had worked in support of economic development. When, later, favorite areas such as Dow's Swamp were taken from us, no organized howls of protest were heard. Such things were taken for granted as a normal result of development. But by the mid-1960s organizations everywhere recognized the threat to what had seemed before to be an apparently infinite environment. The battle began to preserve for future generations those areas that had so far survived exploitation, to control thoughtless pollution, and to prevent the indiscriminate use of chemicals that threatened wildlife. In 1972, the Club's objectives were rewritten to reflect the new motivation:

> To promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and cooperate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

On the national scene, the new emphasis is being supported by the publication in *The Canadian Field-Naturalist* of, for example, excellent papers on the effects of chemicals such as PCBs in the environment, and the internationally acclaimed issues on the status of the Peregrine Falcon. The

local Club established a Conservation Committee of Council and became heavily involved in the battles to defend the Mer Bleue and Gatineau Park, and more recently to defend many other natural areas of the Ottawa-Carleton Region.

Today, the Club continues its dual role, publishing *The Canadian Field-Naturalist* on behalf of all Canadian naturalists, and performing the functions of a typical local natural history club — arranging excursions and lectures, publishing a local magazine, and attempting strenuously to protect from further development many areas of significance to natural history.

A successful one hundred years? Certainly! The Club's founders would surely be pleased with what transpired from that first meeting on 19 March 1879. The Club has evolved to meet the needs of naturalists over a period of immense change in Canada, thousands of people have benefited directly from their association with it, and many more thousands have benefited indirectly from its achievements. More could have been done, particularly on the local front, for it is surely ironic that a club formed one hundred years ago to study Ottawa's natural history has been forced to scramble hurriedly during the last few years trying to acquire sufficient knowledge of local areas (some only ten miles from Parliament Hill) to support their preservation and conversation.

Although the celebration of our Centennial Year will be largely retrospective, some time should be spent thinking about and discussing our current roles and objectives in terms of future needs. Some predictions can be made with a reasonable degree of confidence. These are:

— the need for *The Canadian Field-Naturalist,* or an equivalent journal, will continue into the foreseeable future;
— the pressure on natural environments and living things will continue to increase, in the short term at least;
— the potential for increasing public interest in and concern for natural history will increase as the amount of leisure time continues to increase; and
— in the longer term, leisure activities, if uncontrolled, will become a serious threat to natural environments.

Let us now examine our objectives in these terms. The second objective, "to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible," is certainly appropriate. Although several local Club members have expressed the opinion that *The Canadian Field-Naturalist* has become too "professional" or too "scientific" to be published by a club largely made up of amateur naturalists, I remain convinced that the Club should continue to publish *The Canadian Field-Naturalist* on behalf of all Canadian naturalists at least until it is demonstrated that another organization could provide it a better home.

Similarly, the third objective, "to support and cooperate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things," will continue to be appropriate. Our recent performance in support of this objective has not been outstanding and the Club should concentrate on becoming more involved with other organizations. To attempt to do this effectively on a national scale would be unrealistic, but more could and should be done to promote effective cooperation with organizations in Ontario and Quebec.

The first objective, "To promote the appreciation, preservation and conservation of Canada's natural heritage," sounds impressive but is as a separate objective, the least realistic for The Ottawa Field-Naturalists' Club today or in the future. We do support it to some extent by publishing *The Canadian Field-Naturalist* and by cooperating with other organizations, but some modification of the objective appears necessary if the Club is not to pretend it is trying to duplicate the function of a large national conservation organization such as the Canadian Nature Federation. This is not to say that I feel The Ottawa Field-Naturalists' Club should become overly parochial, but I do think that the stated objectives of any organization must represent specific, realistic challenges that can be pursued effectively.

Finally, I would urge the Club to reintroduce the objective "to study especially the natural history of the Ottawa District," with this or some similar wording, to reflect the localized nature of most of

our activities and the need to continue increasing our knowledge of the district. During the conservation battles of the last few years, local planning bodies have come to recognize the Club as the authoritative source for much of the data on which to base decisions affecting the natural environment. This recognition is due entirely to the hard work of relatively few members. Past appeals to members to help in this endeavor by turning out for inventory-type excursions have largely failed. If the Club is to succeed in meeting the challenges for the future based on the predictions listed above, it must surely focus again on the original objective, chosen on 19 March 1879 — "the study of the Natural History of this locality."

Biology — The Unknown Science?

YORKE EDWARDS

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Biology is a science largely unknown to the people of the world. If life is the most important "thing" on Earth, this is a strange condition. The disturbing result is that not only is the man in the street largely ignorant in all things biological, but also that decisions on how man will treat our life-support system — Planet Earth — are made without biological understandings. Biology is largely missing as general knowledge, hence also as an automatic aid to intelligent decisions. When, on occasion, biology does happen to be given its day, there is no background of accepted status to give it weight. Biology has little hope of being valued or even understood if it is to surface in public affairs only at moments of crisis.

Scientists do a remarkably good job of keeping the public uninformed. This is partly because the public is rather narrow-minded about what is important, which creates some reluctance on the part of scientists to become too visible. But then, of course, a more informed public might be more understanding. When we add to this picture the high proportion of scientists unable to be very informative about their work to almost everyone, the reasons for science's isolation from the man in the street are clear and appear to be formidable.

The poor record of scientists being intelligible and convincing in public seems to be programmed that way by the nature of both today's science and today's scientists. Science today is largely concerned with exploring smaller and smaller bits of our world, with things beyond the awareness of everyday human experience. Scientists lead this trend, but few are helping to put the bits together into more understandable wholes. It is the era of the specialist. By contrast the generalist in science has become rare, which I am convinced endangers both science and the world.

The generalist in science is a necessary companion to the abundant specialist who is traditionally learning "more and more about less and less." The need is not just to assemble what we know about the world into forms meaningful to many, it is also a matter of possessing the resulting wisdom necessary for survival.

Man's wildly compounding knowledge has him more and more in control of his support system Earth in an accelerating use of this control that is quite out of control. Science feeds the largely destructive trend. Few people, including most scientists, can glimpse what is really happening, for the quality and quantity of the effects are beyond the sensory capacities of most people. Understanding, acquired from those few who do understand, is the only hope of self control, understanding that comes from broad insights into the world and how it functions. Science must do a much better job of arranging "more and more of less and less" so that bit plus bit becomes a somewhat visible, somewhat accurate, somewhat understandable whole.

Many scientists consider the discovery of truth to be their sole justification. For example, they regard the basic discoveries in atomic physics as standing alone; atomic warheads are therefore other men's burdens, not those of the pure scientists. This assumes it not true that achieving atomic fission made Hiroshima's devastation probable, even inevitable in the political climate of the time.

In most respects all of us have minds not much changed from those of ancestors in Ice Age caves. The products of science available to us all are power in the hands of ignorance. If science put the power there, and continues to do so without adding very effectively the controls of understanding, we are surely building systems for our own destruction. Only science can correct this situation. We need a new morality in the sciences, which would result in major efforts to make science and its influence on Earth understandable to those outside the ivory towers, and to those in them too, for most scientists do not understand most science.

There is a modern myth in our culture that the scientist is among the most brilliant and wise of men, understanding the world as few others do. Some scientists believe this. But there are many

people who do not, and in fact, from his specializations, and from his frequent mental and physical isolation from the worlds that most people experience, there is an emerging image in our society of the scientist being rather dangerous.

Inevitably, dedicated specialization results in tunnel vision. Neither the specialization nor the resulting narrow view of the world are by any means confined to scientists in our society, nor is the trend for these many specializations to be increasingly specialized. But they are relatively unimportant outside of science. It is specialization within science itself that can keep people awake at night.

Science has given us formerly unbelievable powers and capabilities at the price of mushrooming humanity in a disintegrating support system. If it is not already too late, the end of irresponsible science is the only cure, and then only if irresponsibility is replaced by responsibility, not just for tomorrow's new problems but for yesterday's legacy of old ones as well.

It is fashionable to say that "It was the side-effects that got us." There can be no clearer evidence of our narrow views. "Side-effects" are a tunnel-vision illusion, for the broad view will see only "effects."

I have begun this essay with the broadest possible sweeps quite by plan. My resulting generalizations contain many of the "part truths" and "too general" sorts of "facts" that drive most scientists into ever deeper specializations with their attractively simple foci of study. In disciplines properly requiring the greatest possible degrees of accuracy, the uncontrolled drift of scientists toward the high accuracy areas is perhaps predictable. But I wonder if this is both science's blind alley, and Earth's sentence to increasing impoverishment of its life. While the sciences choke on ever increasing flows of new detail from examining the parts of the world, not many scientists are putting the pieces together into meaningful wholes of knowledge. We need more syntheses by more generalists, more generalization even at the calculated risk of less accuracy.

The need is not so much for fewer specialists as it is for more generalists, not so much for less publishing of science as for more interpretation of science where there is recognition of the value of generalization that may be accurate enough to be of great value, while also being uncertain and perhaps therefore inaccurate to some degree.

Conquering the tsetse fly "problem" in Africa is receiving much research. The tunnel vision approach would focus simply on eradicating flies as a relatively simple biological problem. The generalist might be aghast at such efforts in view of the vast ignorance of what the power to destroy the tsetse would really accomplish through chain reaction and time. Tunnel vision sees only flies, with perhaps another vision of people happily eating more cattle. A broader view might see over a quarter of a continent an end result of human poverty and misery in rapidly expanding deserts that mark the end of rich faunas and floras once containing reasonably successful people. The innocence of dropping such a powerful force as easy tsetse eradication into the lap of a humanity largely blind to the terrible powers involved has many parallels in history, where seemingly small additions to the capability of man has resulted in world changes too big for most people to see, and too drastic for those touched by it to understand.

Science has rarely been in the arena of public debate, expounding its discovered truths. Without science participating in human affairs with a vigor equal to its unique capability for discovery, what hope is there for wise choices? What hope for future life in high quality environments?

Not always do the issues have the potential inflation factor of tsetse flies or nuclear fission. But the effects of lesser tinkerings add up, with overharvesting here, mercury waste there, disease eradication somewhere else, each with their chain reactions. Not long ago I read an enthusiastic article from a Canadian botany department assessing the harvest potential from the kelp growing along the British Columbia coast. A new industry was about to be born, and the facts were proclaimed as if from the local Chamber of Commerce. On impulse, I penned a note to the author asking to what extent the intended harvest would be also habitat removal to the rich and specialized fauna of the kelp "forests," and what animal species were involved. The reply was a refreshingly candid admission that the thought had not occurred to him. Tunnel vision was perhaps quite properly his view of the kelp beds,

but there seemed to be no other view involved. No one had considered effects and chain reactions.

I work in one of Canada's larger museums with specialists in history, zoology, botany, ethnology, archaeology, and other fields. When I first examined this small community of mixed disciplines, I was impressed by the isolation from the others in which each group worked; but I became more impressed later on those rare occasions when cross-communication between two of them triggered an exciting and enlightening experience for both. A common language of biology bound together the life sciences, and an ecological dimension common to biology and anthropology gave them common ground from which to exchange ideas. But history was different; for traditional reasons it was unable to comprehend either biological or ecological concepts, so was unprepared to consider them of use. This was the most impressive museum experience of all, and I have tried to understand it, not just for reasons of improving a museum, but for its possible deeper meanings. The new and popular interest in ecology has not touched the historians about me, at least not as historians. To converse with them I must drop my ecological view of the world and lean heavily on my everyday experiences with people interested simply in experiences with people. This sort of superficial observation of the human scene has been man's need and entertainment since man became man, perhaps before, and it seems that traditional history as a discipline is largely a formalized version of this trait. A scientist might conclude that attempts to explain history without using the knowledge of biology and ecology must result in very limited understandings. A historian may counter that to record the passing scene is enough; let others try to explain it.

The science-less view of history must be largely the view of the world as seen by most people. There is little concern with cause and effect, the only part of the world worth noting being people. Their successes and failures, if explained at all, result from their own interactions, chance, and the supernatural. Modern history of course has its ecologically oriented historians, or so the literature would suggest unless they are instead scientists trespassing in history. Nevertheless, science is not a useful part of traditional history, not to the extent of its being a constant means of understanding the past.

This ignoring of man's supreme accomplishment in recent times — scientific knowledge — in understanding the world is the standard human condition. We gladly accept the wealth and ease that science has given us. We eagerly learn to apply the directions of science for achieving health and comfort and riches from our environments. We spray the aphids on a bush, and thereby unknowingly poison a hundred other kinds of creatures, including ourselves. We pour chemicals of unknown capability into a sewer, for safety, and thereby take food in the form of fish from the mouths of a thousand people. We remove a rich forest with machines from an endless list of discoveries, and for quick profit burden future generations with square miles of sun-baked wastelands. To learn to exterminate a fly may be, unknowingly, to learn how to create deserts over half a continent. We are given power far greater than we realize, far more given to unexpected chain reactions than we can guess, by a science not doing the important part of its job. The brilliance that gives inventions and discoveries must come from a system discovering and disseminating also some understanding of the impact of those inventions and discoveries upon the face of Earth.

The world needs generalists in science, using new approaches in science, to discover the true meanings of its discoveries, and to report them in useful form giving the sure, the probable, and the possible effects of their use. Only such synthesizers, at all levels of science, can scientifically reconstruct whole animals, rebuild whole habitats and whole landscapes, putting aggregates of knowledge back into the public reach so that whole things, or at least meaningful parts of things, are understood as far as men understand them. This is not easily done. That is why science fails to do it. By the standards of accuracy demanded in most sciences these reconstructions will have some inaccuracy. If this is unavoidable, it must become acceptable insofar as its accuracy is useful, because there is not just a general intellectual need for non-scientists to see more sums of knowledge, there is some urgency since our science and technology seem to have us programmed in several ways to self-destruct.

The challenge of evolving effective methods for such a prevalent new dimension to science may

not be the main problem. Present scientific circles frequently regard as somehow second class those of its scientists that put much effort toward being understood in lay society. It is almost as if there was a cult for obscurity. Perhaps we have a long way to go.

Science must of course be encouraged to pursue the obscure. But let it also learn to reassemble the parts. Biology is not presently a force in world affairs because it does not communicate well, at least not at the level of public understanding. Economists (and merchants, and lawyers, and others) make decisions instead. Until biologists begin to replace economists because they have a superior ability to correct errors and to predict events (which should not be too difficult) there is not much hope for realistic decisions in human affairs.

If life is indeed Earth's most important attribute, biology is then the discipline best able to guide man's decisions concerning his (and Earth's) welfare. If this is even partly so, we need a biology not just active in knowing more of less and less, but also at knowing more of less plus less. Why? So that people may understand their world. And so that humanity may survive with dignity.

The Canadian Field-Naturalist — the *Status Quo* or a New Direction?

To some of us the most significant and lasting contribution that The Ottawa Field-Naturalists' Club has made to society is the publication of *The Canadian Field-Naturalist*. From almost the very beginning, since 1880, the club has published a scientific journal and from the early years (1889 onwards) its scope has included papers on the natural history of Canada. This centennial year of the club is a time for contemplation, reflection, and, by the express wishes of Council, a reassessment of *The Canadian Field-Naturalist's* rôle as a publication of the club and its relationship to the club.

Do Problems Exist?

In general, the present members of the Council of The Ottawa Field-Naturalists' Club are reported to be "uncomfortable" about *The Canadian Field-Naturalist*. Some would prefer more papers by amateur naturalists, more items of local interest, more club content, and less emphasis on professional scientific papers. Some, reflecting comments made by local members, question why a portion (40% in 1978) of their membership fees should be allotted to a publication that appears to have minimal relevance to the club and why those members who are not interested in *The Canadian Field-Naturalist* should receive it at all. Fortunately, others understand that *The Canadian Field-Naturalist* is providing a much needed service to Canadian natural history. Most people agree, however, that the club is the most appropriate publisher of *The Canadian Field-Naturalist,* at least until a more suitable alternative organization is evident.

There is no doubt that the relationship between *The Canadian Field-Naturalist* and The Ottawa Field-Naturalists' Club as its publisher is a very important one. Unfortunately, however, uncertainty regarding this relationship continues to arise from time to time. In a way the publication of a national scientific journal by a basically local natural history club is an anomaly, especially as *The Canadian Field-Naturalist* is recognized as *the* "official" publication of the Ottawa club. It is the only publication specifically mentioned in the club's constitution and is sent to all club members.

Until recent years many of the members of Council were senior scientists (the Ottawa area with many federal government departments has a high concentration of scientists) with strong interests in the journal. They recognized its broad scope and scientific significance. Today most Council members are not professional field-research scientists, hence the composition of Council is probably more comparable to those of other local natural history societies. Many of the professionals (mainly field-biologists) who were once active members of the club and served on its Council are now involved in different activities. Therefore, is it unexpected that some members of the present Council don't really understand *The Canadian Field-Naturalist?* Their uneasiness about it is evident in their current re-evaluation of its rôle and in the stated view of the Chairman of the Publications Committee that the club should publish a journal that is in keeping with the wishes of the membership. But exactly what is meant by "membership"? Is it considered to be the "local" (arbitrarily defined geographically), largely non-professional members, the people who can most easily communicate their opinions to Council? Or does it also include, as it should in the true sense, the local and non-local professionals; the former local members who have moved away but still want to keep in touch with the club; the distant people who became members because they wanted to receive *The Canadian Field-Naturalist* (prior to 1976 this was the only way an individual could receive the journal); and possibly others who, although they may dwell far from Ottawa, wish for other reasons to belong to the club? And shouldn't the opinions of our subscribers and other readers also be considered?

The members of Council are voted into office at the Annual Business Meeting. The slate drawn up by a Nominating Committee each year from the local members of the club has always been acclaimed into office by the local members who attend. To my knowledge there has not been a single club election in recent decades. Considering that the club's Council is assumed to represent the

membership, one can interpret the "wishes of the membership" to be equivalent to the wishes of the Council members after they have taken into account the expressed opinions of local members. In forming his/her opinion will each member of Council think of his/her own personal preferences or will he/she consider the broader outlook, recognizing *The Canadian Field-Naturalist*'s rôle in the advancement of scientific knowledge of Canadian natural history? And is recognition being given to all those the journal now serves beyond the interested local members, namely the subscribers, external members, authors, and the many readers who consult it in libraries?

The major reasons for my editorial then are: first, to alert those concerned about and interested in *The Canadian Field-Naturalist* to be informed of the present uneasiness of the Council and the steps it is planning to take; second, to solicit informed input from our readers to help the Council decide whether the *status quo* should be maintained or *The Canadian Field-Naturalist* should take a new direction; and third, to state my personal opinion regarding the journal's present status and rôle and my thoughts regarding its future.

Functions of *The Canadian Field-Naturalist*

To me *The Canadian Field-Naturalist* fills the important need for a national field-oriented natural history journal publishing, and hence recording for posterity, original and significant information with relevance to Canadian plants and animals. For some years now there has been a drop-off in club activity in geology and palaeontology and there has been a concomitant dearth of manuscripts submitted to *The Canadian Field-Naturalist* on these subjects. This is unfortunate because these areas of natural history were once very strong ones in the club and the journal. Thus *The Canadian Field-Naturalist* currently plays a rôle in advancing knowledge in the biological sciences as authors record, analyze, and interpret their data. In recent years this function has become more important because several journals formerly available to field-biologists will no longer accommodate purely observational (non-experimental) data nor descriptive passages outlining the results of field investigations. *The Canadian Field-Naturalist,* by acting as a model for content and format, also serves to stimulate amateurs and young biologists to record their observations and to start their own investigations leading to fruitful lifetime hobbies or careers as field-biologists.

There is no doubt for many of us that the scientific quality of *The Canadian Field-Naturalist* is currently high. Otherwise it would not attract submissions from a wide variety of natural scientists, nor would respected scientific experts serve as Associate Editors or referees, nor would the National Research Council of Canada have supported its publication by awarding substantial grants when funds were needed. In earlier years, however, *The Canadian Field-Naturalist* was neither completely rejected nor completely accepted by the scientific community because it did not use the peer review system and was only partially scientific. Today it is accepted as a scientific journal and is widely distributed, reaching many lay and professional readers including those in Canadian and foreign libraries. It serves to varying degrees both writers and readers by permanently preserving valuable information of national importance and by helping to build the reputation of professionals who must publish in a refereed journal of high standards and quality.

Although from time to time *The Canadian Field-Naturalist* publishes significant scientific papers concerning Ottawa biota, I agree that in general it currently does not relate very much to local naturalists with purely local interests other than in its publication of the reports and notices of the club. Current editorial policy does exclude papers that are of only regional or local interest, i.e., those that are not nationally significant, but these papers are appropriate for and can be accommodated in society newsletters and in regional or local natural history publications, many of which are of excellent quality. If *The Canadian Field-Naturalist* were to publish these items, it would again be in a gray area and eventually it would lose its current status and reputation as a primary scientific publication.

I feel that most naturalists should find something of interest in every issue of *The Canadian Field-Naturalist* although I recognize that it does not fill the needs of all the local members. But the club does publish five times a year an excellent magazine, *Trail & Landscape,* containing items of local

natural history interest, matters of conservation in the Ottawa area, plus announcements of lectures, excursions, and special meetings of the club. As far as many local members are concerned *Trail & Landscape* in fact *is* the voice of their club, yet it has no official status as a club publication and its continued existence is not completely assured. Certainly re-evaluation of *Trail & Landscape*'s status, rôle, and relationship with the club seems urgently required in the present context.

Clearly *The Canadian Field-Naturalist* is filling the need for a field-oriented national natural history journal; it serves both amateur and professional naturalists and field-biologists, maintains high scientific standing, and has assured itself of a place in history as it records the current state of the discipline. In doing so it is also fulfilling the second objective of the club, "to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible."

Are Amateur Naturalists Considered?

One of the serious concerns of the Council of The Ottawa Field-Naturalist Club is the position of amateurs vis-à-vis *The Canadian Field-Naturalist*. Various members have recently expressed particular concern that the highly professional nature of the content and the more prestigious format of the journal have intimidated amateur naturalists and thus prevented them from submitting manuscripts. At Council's request a survey was conducted of two volumes from each of the last three decades and all authors were classified as "professionals" if they had an institutional address and as "amateurs" if they had a home address. The survey clearly indicated a gradual decade-to-decade decrease in the number of papers by authors classed as amateurs. But these results are open to several interpretations. The question of whether the number of submissions from amateurs with data worthy of publication has decreased because of the journal's content and format cannot yet be answered. I sincerely hope, however, that no potential author has been deterred from submitting a paper that he or she felt was of national significance.

Let us consider some possible factors that could have contributed to the results obtained in the survey.

a) Is an institutional address an adequate criterion for identifying an author as a professional? It must be realized that a professional in one field of science may be an amateur in another discipline even within the biological sciences. Also many authors prefer to use an institutional address even if the paper they submit has no relevance to their particular profession. Thus the survey could not identify all the amateurs in the true sense of the word.

b) Are the amateurs of today sending their manuscripts to other publications that were either not in existence or not of sufficient interest or quality for amateurs of earlier years? In general, over the last few decades most scientific publications, including *The Canadian Field-Naturalist*, have changed to become less anecdotal, more structured, and more polished. At the same time there has been a dramatic increase in the number and quality of alternative sources of publication for natural history notes. Some of the regional and local publications of natural history societies have changed from mimeographed newsletters, where often virtually any material submitted was accepted, to a printed booklet format, where raised standards are evident. The high calibre of these publications has enhanced the image of the organizations publishing them and surely is appreciated by their members. *Trail & Landscape* is an excellent example.

c) Is amateur science recognized as the initial training ground for many of those who will eventually make their living as professional field-biologists? Perhaps these young people with their special enthusiasm for natural history are our most inspired amateurs. Although many manuscripts submitted to *The Canadian Field-Naturalist* are from authors with institutional addresses, often the authors are really students, i.e., advanced amateurs who are not yet professionals.

d) Are today's amateurs motivated to make their own observations systematically and rigorously and to write them up for publication? In the past this motivation was often supplied by interested

professionals who spent considerable time answering questions, identifying organisms, and interpreting often routine natural phenomena for members of the public, including amateur naturalists. Amongst these were occasionally people with exceptional latent talent who needed only a bit of interest to be shown in them by such notables as Jim Baillie and A. F. Coventry in Toronto, Clifford Carl in Victoria, Earl Godfrey in Ottawa, and many others. Although these exceptional professionals published valuable papers on their own research, perhaps equally important although often unsung contributions on their part were in providing encouragement to beginning naturalists to observe and record significant data. Because of our increasingly complex society, and the drives to establish their own reputations and empires, it is my impression that fewer and fewer professionals in universities, museums, and government departments take time to communicate with amateurs. Therefore, often amateurs now cannot readily discern whether their observations, sometimes just important single observations, are of particular interest and significance. Moreover, the incentive for amateurs to report (write up for publication) their observations may be lacking without this professional encouragement.

e) Do some of the few particularly keen amateurs who want to help advance knowledge prefer to work under the direction of a professional field-biologist rather than on their own? Certainly opportunities to do this are available and advertisements specifically outlining projects are fairly widely circulated. Undoubtedly any publications resulting from this type of joint amateur-professional collaboration bear an institutional address.

f) Overall, do more amateurs today pursue natural history for the particular pleasures it brings to them rather than through a desire to carry out a particular study or to contribute to knowledge? With the increased leisure time in our changing society as well as increased incomes, people are travelling more extensively, not only in Canada but all over the world. They enjoy adding new species to their life lists, and taking photographs and making sound recordings using the array of technical equipment now available to them. The greatly increased mobility and opportunities for fleeting but exciting glimpses of different biomes present a far different situation than in earlier years. Then people used to be more sedentary and amateurs were more interested and persistent in devoting time to the valuable study of a single species or a few local species. Their repeated, often tedious, observations over long periods of time provided data that could be synthesized and interpreted. New trends and even definite changes were uncovered. Of course, with the advancement of knowledge, it is no longer so easy to find new fields to conquer, e.g., to describe species or habits or extensions of ranges. Are many of today's amateurs still willing to do potentially valuable long-term studies in the field and to analyze and interpret their data? Or are they preoccupied with spotting rare species here or travelling to distant lands to identify, check off, then move on to the next, rather than studying, watching, and recording?

g) Are amateurs reluctant to send a manuscript to *The Canadian Field-Naturalist* because it is too "scientific"? Those of us currently responsible for the content of the journal are anxious to have submitted by amateur and professional naturalists and field-biologists papers on results of sound original investigations in any field of natural history that is of significance and relevance to Canada. The pages of the journal are open to all amateurs whose papers meet these criteria. Reluctant amateurs should be particularly aware that important data not put on record may be lost to science. Although we endeavor to maintain the journal as a first-class scientific one, we also emphasize that scientific writing does not need to be, and preferably is not, pretentious but rather is simple and straightforward. Ideally it should be clear, concise, accurate, logical, and interesting. The journal is a broad general one and it is important that the papers we publish be understood by as many as possible of our readers. Although we expect trained biologists to write their manuscripts in the accepted style (and not all do), I emphasize here that we are particularly willing to help amateurs by giving advice and guidance on writing to improve their submitted manuscripts. The major criterion for acceptance is the importance of the information and its relevance to Canadian natural history.

In the past, amateurs played an extremely important rôle in the advancement of knowledge in the natural sciences, particularly in field biology. Are amateurs still doing so? My questions and possible interpretations of the results of the survey regarding amateurs may help to illustrate that answers to seemingly simple questions are often complex and involve many interrelationships.

Future Role of *The Canadian Field-Naturalist*

The existence of *The Canadian Field-Naturalist* as a primary scientific and hence archival publication depends on several factors. These include the submission of manuscripts that, after review by competent referees, are found acceptable for publication; the availability of sufficient funds to cover publication and distribution costs; and the agreement of the publisher to maintain the journal as such.

The Articles and Notes published in *The Canadian Field-Naturalist* are refereed and almost all undergo minor or major revision before they are accepted. But there are also several non-refereed pages in each issue containing general information considered to be of wide interest. Should the number of these pages be increased? Should they contain more items of interest only to the local club members? For instance, would items that now appear in *Trail & Landscape* (sent to all local members and any other members who request it) or in *The Shrike* (the club birding newsletter, available only on subscription) be suitable? If so, would these other publications still be maintained as they are now?

At present the major expenses of the journal are met by page charges levied to authors and the subscription fees from institutions. Individual subscribers number just over 300 but their fees plus the portion allotted from the membership fees are not insignificant. The results of a questionnaire circulated to the club's membership with the renewal forms for 1974 (see editorial in Volume 89(1), 1975) indicated that most people were members in order to receive *The Canadian Field-Naturalist,* but at that time only institutions, not individuals, could subscribe. Those who were club members in 1975 were given a choice starting in 1976 of maintaining their membership in the club with a portion of their membership fees (currently 40%) going to the journal, or of becoming subscribers for exactly the same annual fee but with the entire fee (100%) going to the journal. I wonder how many through knowledgeable choice, apathy, reluctance to change the *status quo*, or perhaps lack of knowledge of the financial implications to the journal, chose to remain members of the club. The opportunity for a member to become a subscriber was offered only *once* although there is no reason anyone wishing to do so shouldn't change from being a member to become a subscriber at the start of any year.

Because the club does have members across Canada and elsewhere, whether in name only or not, it considers that it speaks for a national and international membership. Although all members potentially have votes at the Annual Business Meeting and can elect the Council and introduce new business at the meeting, it is the local members, now mostly non-professionals, who come to the meeting, vote, and serve on the Council. But these are the people who will control the future of *The Canadian Field-Naturalist.*

The Council of The Ottawa Field-Naturalists' Club intends to produce within a year or so a statement regarding the desired rôles for all the club's publications and their relationship to the club. Thus the specific positions of *Trail & Landscape* and *The Shrike* as well that of *The Canadian Field-Naturalist* will be clarified and the rôle of each as a club publication defined. Because this is a complex matter, the Council executive has assured me that any changes in direction will be implemented slowly. Therefore, after reading the background material in this editorial, but not being constrained by it to matters covered therein if there are other points to be brought out, interested persons are invited to state their views. I hope that favorable as well as critical comments, if justified, will be made because it is important to reaffirm where the journal is performing satisfactorily as well as where it may need modifying. Subscribers have one way to influence the journal directly, and that is by maintaining or discontinuing their subscriptions, but they can also express their views regarding *The Canadian Field Naturalist*'s rôle as a publication of The Ottawa Field Naturalists' Club. I hope

all interested readers will put forth their thoughts because there is still time to have input into the deliberations of Council on this matter. Indeed, I invite them to do so by writing directly to the club (Box 3264, Station C, Ottawa, Ontario K1Y 4J5); carbon copies to the Editor would be appreciated. More formal comments as Letters to the Editor for publication are also solicited.

The 100-year history of the club and the journal is perhaps unique and it is desirable that the two maintain a good relationship. Although the Editor and the editorial board are currently responsible for the editorial policy and content of the journal, ultimately it is the Council's decision that will shape the future of *The Canadian Field-Naturalist.*

This editorial is a distillation of many hours of discussion and analysis of the past and the current situation as interpreted by my husband and me. Therefore, by expressing our concerns, I hope that the opinions solicited from readers of all categories will help to influence the outcome of the current re-evaluation of the rôle of this journal. Furthermore, I hope the Council's written statement will solve the misunderstandings and misinterpretations, calm the Council's current uneasiness, clarify the club's policy about its publications, and strengthen the position of *The Canadian Field-Naturalist* by formal reaffirmation of its present rôle as a primary scientific natural history publication published in Canada and relevant to Canada.

LORRAINE C. SMITH
Editor

Demographic and Dietary Responses of Red-tailed Hawks during a Snowshoe Hare Fluctuation

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Adamcik, Robert S., Arlen W. Todd, and Lloyd B. Keith. 1979. Demographic and dietary responses of Red-tailed Hawks during a Snowshoe Hare fluctuation. Canadian Field-Naturalist 93(1): 16–27.

Red-tailed Hawks (*Buteo jamaicensis*) responded functionally but not numerically to a cyclic fluctuation of Snowshoe Hares (*Lepus americanus*) near Rochester, Alberta. During 1966–1975, 89% of the resident pairs laid eggs, a nesting density of 1 pair per 8.3 km^2. Mean clutch size (overall 2.2) ranged between years from 1.7 to 2.6, partly in response to prey-density changes. Mean hatching dates varied from 30 May to 10 June. Marked differences in annual productivity, 0.28 to 1.90 fledged young per breeding pair, primarily reflected nestling mortality. About 50% of all nestling losses were associated with food shortage. Seventy percent of annual variation in mortality through age 4 wk was jointly attributable to the frequency of rain and the weight of food brought to nestlings. The latter varied directly with Snowshoe Hare densities. The stationary population of breeding adult redtails contrasted with the numerically and reproductively cyclic horned owls (*Bubo virginianus*), but resembled redtail and other temperate-zone raptor populations further south. Food reductions during hare declines in the boreal forest ecosystem do not seem to be critical to survival of redtail nestlings unless combined with above-average rainfall.

Key Words: Red-tailed Hawk, *Buteo jamaicensis,* Snowshoe Hare, *Lepus americanus,* population dynamics, cyclic fluctuations.

A study of Red-tailed Hawks (*Buteo jamaicensis*) was conducted in central Alberta during 1966–1975. Its objective was to examine changes in raptor demography, food habits, and predatory-prey interactions during one complete population cycle of the Snowshoe Hare (*Lepus americanus*). Early results of this work were reported by Meslow and Keith (1966) and Luttich et al. (1970, 1971). McInvaille and Keith (1974) summarized findings through 1971, the year of peak spring densities of hares on the study area; they examined intraspecific relationships among redtails and interspecific relationships between redtails and Great Horned Owls (*Bubo virginianus*). They also assessed the effect of increasing hare densities on redtail breeding biology, and estimated rates of predation on prey populations. The most recent paper, that of Keith et al. (1977), examined the role of Red-tailed Hawks and other predators in the cyclic fluctuations of Snowshoe Hares and Ruffed Grouse (*Bonasa umbellus*).

The hare population at Rochester declined after spring 1971, reaching the lowest point in its cycle by spring 1975. Over those 4 yr, significant changes occurred in reproduction, nestling survival, and food habits of redtails. This paper describes such changes and examines their relationship to prey densities. It also presents a general analysis of redtail productivity since 1966.

Methods

Study Area

The 162-km^2 study area (130 km^2 in 1966) was a block of mixed agricultural and forested land near Rochester, Alberta, about 100 km N of Edmonton. Luttich et al. (1971) and Rusch et al. (1972) described the vegetation, topography, and land-use practices on the area; McInvaille and Keith (1974) classified the major habitats and outlined their distribution as of 1971. Except for secondary growth in fire-killed areas, and some further clearing of forested land for pasture, the study area changed little over the next 4 yr.

The breeding season for redtails in central Alberta is early April through July. Mean temperature at Rochester during this period is 12°C, with average minimum and maximum temperatures of 6°C and 18°C, respectively. Temperatures near freezing have been recorded in all summer months; and during extended periods of cloudy or rainy weather in July and

TABLE 1—Summary of weather data during 10 breeding seasons of the Red-tailed Hawk near Rochester, Alberta[1]

Periods in nesting cycle and types of weather data	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	Mean
Courtship											
Days in period[2]	26	31	31	25	23	27	36	31	22	24	28
Mean daily temperature (°C)	-1	2	4	9	5	5	2	3	6	5	4
Days with precipitation (%)	31	19	29	52	9	15	31	29	32	46	29
Mean daily precipitation (mm)	1.7	0.7	0.6	1.2	0.1	0.8	1.0	0.8	1.1	0.8	0.9
Mean snow depth (cm)	7	25	1	2	9	25	24	6	23	8	13
Days with snow on ground (%)	65	97	29	40	52	78	83	58	82	46	63
Incubation											
Days in period	32	32	32	32	32	32	32	32	32	32	32
Mean daily temperature (°C)	12	12	10	11	10	13	12	11	9	11	11
Days with precipitation (%)	44	25	34	34	22	22	22	38	50	53	34
Mean daily precipitation (mm)	2.1	1.2	0.8	1.2	0.4	1.0	0.9	2.1	0.7	1.5	1.2
Nestling (pre-tethering)											
Days in period	28	28	23	28	26	30	28	34	24	27	28
Mean daily temperature (°C)	13	14	14	14	17	13	14	15	15	13	14
Days with precipitation (%)	39	43	57	32	39	57	50	53	42	70	48
Mean daily precipitation (mm)	1.1	0.9	1.9	1.0	4.1	4.2	3.0	4.2	0.9	4.3	2.6
Tethering											
Days in period	20	28	27	22	28	21	23	16	31	22	24
Mean daily temperature (°C)	17	18	16	16	16	15	13	15	15	19	16
Days with precipitation (%)	60	43	67	55	64	67	61	69	74	55	62
Mean daily precipitation (mm)	3.9	0.6	3.5	4.2	6.7	5.0	1.5	1.6	4.8	3.5	3.5

[1]Weather data were collected at the Meanook Meteorological Observatory, 26 km N of Rochester.

[2]Total days in each period were determined as follows: courtship—date of first observation of a red-tail on the study area to mean date of start of incubation; incubation—mean date of start of incubation to mean date of hatch (32 d); nestling—mean date of hatch to mean date of tethering; tethering—mean date of tethering to mean date of release.

August, daytime maximums around 7°C are not uncommon. Although occasional snow flurries occur as late as mid-May, most precipitation from late April to August falls as rain. Total spring-summer (15 August — 31 August) rainfall is variable, ranging from 11 to 44 cm during our study. Heavy showers and rainstorms are common, but precipitation more often occurs as light rain over several days.

Demographic Methods

Methods of censusing raptors, tethering nestlings, and estimating prey densities were identical to those described by McInvaille and Keith (1974). Snowshoe Hare and Ruffed Grouse population estimates were revised slightly after additional analyses. We expanded the small-mammal census to include a spring (April-May) index for 1973–1975, and determined summer (June-July) densities of juvenile Richardson's Ground Squirrels (*Spermophilus richardsonii*) on two study areas beginning in 1969. Waterfowl data used in the present paper were based on counts along a 0.4-km-wide aerial transect between the towns of Cold Lake and Swan Hills. This transect passed about 11 km N of Rochester. Weather data were collected at the Meanook Meteorological Observatory, 26 km N of Rochester.

Examination of Weather Data

To analyze relationships between weather and productivity of redtails, we arbitrarily divided their reproductive cycle at Rochester into four stages: courtship, incubation, nestling (pre-tethering), and tethering (Table 1). The courtship stage began with the first date of observation on the study area each spring. The tethering stage ended with release of the last young we had tethered to obtain food data. Mean dates of first observation, start of incubation, hatch, tethering of nestlings, and release of fledged young during 1966–75 were 5 April, 3 May, 4 June, 2 July, and 25 July, respectively.

Within the courtship stage we examined five weather variables: mean daily temperature, percent days with precipitation, mean daily precipitation, mean snow depth, and percent

days with snow on the ground. The last two variables were irrelevant in the three later stages of the reproductive cycle.

Results

Prey Populations

Spring densities of adult Snowshoe Hares peaked in 1971 at 510 per 100 ha of habitat, and thereafter declined to only 1% of peak numbers by 1975 (Table 2). Because the birth rate was higher in 1970 than in 1971, young hares were more numerous in 1970, and the total spring-summer (May-July) population was consequently higher that year. As with adults, total hare numbers fell markedly after 1971 to about 1% of peak numbers by 1975.

Richardson's Ground Squirrel populations rose between 1968 and 1970, fell to about 25% of their maximum by 1974, and increased again in 1975. During the highest year, adult densities averaged 988 per 100 ha of habitat (closely grazed pastures) in May, and juveniles averaged 3350 per 100 ha in June (Table 2).

Populations of voles *(Microtus pennsylvanicus)* continued to fluctuate during 1971–1975, as in previous years. amplitudes of change between high and low populations were 7- to 32-fold in late summer trap-night indices. Lowest numbers occurred in August 1968, 1971, and 1975. May populations were lower in 1973 and 1975 than in 1974 (Table 2).

Ruffed Grouse were most abundant at 61 per 100 ha of upland forest in May 1968. A major decline took place between the springs of 1970 and 1972, as numbers fell 65% to 16 per 100 ha. The population remained low through 1974, then more than doubled by May 1975.

Sharp-tailed Grouse *(Pedioecetes phasianellus)* increased from 1966 to 1970, but decreased abruptly within the next year and were scarce thereafter (Table 2). Waterfowl trend data for 1971–1975 indicated a general decline of about 50%.

Red-tailed Hawk Numbers, Reproduction, and Nestling Mortality

During 1972–1975, the Red-tailed Hawk population on our study area maintained the approximate numerical stability of earlier years (Table 3). Total individuals varied from 53 in 1967 to 39 in 1975, while breeding pairs ranged from 24 (1 per 6.8 km^2) in 1966 to 16 (1 per 10.1 km^2) in 1973. There was no significant difference between years in portion of the population paired (mean 94%), the proportion breeding (mean 84%), or the proportion of pairs breeding (mean 89%).

Mean hatching dates differed significantly ($P < 0.05$) between years (Figure 1), being latest in 1967 (10 June) and earliest and most variable in 1972 and 1973 (2 June and 30 May, respectively).

Significant ($P < 0.05$) annual variation also occurred in mean clutch size and mean brood size during 1966–1975. Mean clutch sizes were largest in 1970 and 1972 (2.6) and smallest in 1966 (1.7) and 1975 (1.9). Egg counts were made only once per nest, ranged over the incubation period, and included nests off the study area (Table 3, footnote 2).

There was a marked change in the causes and rates of nestling mortality among redtails during 1972–1975 compared with earlier years (Table 3). Losses attributable largely to horned owls averaged 43% in 1968–1969 (Luttich et al. 1971), but dropped to 14% in 1970–1971, as sharply rising hare densities apparently buffered such predation (McInvaille and Keith 1974). Predation by owls recurred in 1972 coincident with a major decline in hares. During 1973–1975, we recorded no horned owl predation on nestling redtails, as Snowshoe Hares became scarce and owl numbers declined through egress and non-breeding (Adamcik et al. 1978). But total nestling mortality on the study area rose from 37% in 1972 to a mean of 66% during 1973–1975. Almost all of such losses occurred before tethering (i.e., with 3–4 wk after hatching) in 1973–1975, whereas only about half had occurred by that time in earlier years.

Of the 30 young lost prior to tethering during 1966–1972, 18 disappeared completely, and the remains of 12 (40%) were found in or below the nest. Four of the latter had been cannibalized by siblings.

In 1973, 8 of 18 (44%) dead young were found in or below the nest, and 6 of these had been cannibalized. In 1974, 4 of 14 dead young starved in the nest, 2 disappeared, 1 was cannibalized, and 7 (50%) died after falling from the nest. Three of the latter seven birds survived their initial fall and were replaced in the nest; two

TABLE 2—Population indices for some prey species taken by Red-tailed Hawks near Rochester, Alberta

Species	Age classes	Time period	Type of population index	Population indices									
				1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Snowshoe Hare[1]	Ad	May	no./100 ha	24	39	93	144	340	510	245	78	23	5
	Juv	May–Jul	no. born/100 ha	103	233	409	644	1983	1650	745	142	77	12
Total				127	272	502	788	2323	2160	990	220	100	17
Richardson's Ground Squirrel[2]	Ad	May	no./100 ha			506	543	988	889	310	(336)	247	370
	Juv	Jun	no./100 ha			(1383)	2130	3350	2185	1090	1265	840	3465
Total						(1889)	2673	4338	3074	1400	(1631)	1087	3835
Meadow Vole[3]	All	Apr–May	no./100 trap nights								0	12	4
	All	Aug–Sep		9	28	1	32	7	5	37	19	14	5
Ruffed Grouse[4]	Ad	May	no./100 ha	32	35	61	42	46	32	16	15	15	34
Sharp-tailed Grouse[5]	Ad male	Apr	no. on lek	10	14	25	31	49	10	—	22	19	20
	All	Nov–Mar	aerial count	54	62	54	70	112	8	39	15	8	4
Waterfowl[6]	Ad	May	aerial count						120	101	94	95	63

[1]Based on data in Keith and Windberg (1978) from four study areas; estimates for 1966–1971 were revised since the study by McInvaille and Keith (1974), but the trend in hare numbers was unaffected.

[2]Mean numbers on two to five study areas; number of adults in 1973 estimated from juvenile numbers in 1973 and mean ratio of adults to juveniles (0.289) in 1972 and 1974; number of juveniles in 1968 estimated from adult numbers in 1968 and mean ratio of adults to young (0.366) in 1969 and 1970.

[3]*Microtus pennsylvanicus*: the relatively low capture rates reflect the fact that small-mammal traplines were largely in forest, with only about 25% of all traps sampling *Microtus* habitats.

[4]Mean number on four study areas (D. H. Rusch, personal communication); estimates for 1966–1971 were revised since the study by McInvaille and Keith (1974), but the trend in Ruffed Grouse numbers was unaffected.

[5]Maximum number of males observed on one dancing ground over several days; and mean number of individuals observed per 100 km^2 during two to five helicopter flights annually covering about 180 km^2 and overlapping approximately half the raptor study area.

[6]Number observed along a 0.4-km-wide aerial transect between the towns of Cold Lake and Swan Hills; the transect passed about 11 km N of Rochester (data courtesy of K. D. Norman, U.S. Fish and Wildlife Service).

TABLE 3—Some population and productivity statistics for a Red-tailed Hawk population on a 162-km² study area near Rochester, Alberta

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Population statistics										
Breeding pairs[1]	24	20	19	18	19	19	21	16	17	18
Non-breeding pairs	?	3	3	3	2	1	2	4	2	1
Resident singles	?	7	4	0	1	2	2	4	2	1
Productivity statistics[2]										
Mean clutch size	1.73	2.00	2.17	2.14	2.56	2.28	2.61	2.00	2.42	1.90
Mean brood size	1.71	2.00	2.07	2.14	2.53	2.17	2.37	1.96	2.26	1.71
Nestling mortality (%)[3]										
0–4 weeks	0	12	24(10)	11	5	11(16)	29(18)	64(45)	45(23)	72(78)
5–8 weeks	5	0	33(27)	28	13	0(38)	12(6)	0(46)	17(22)	25(40)
Total	5	12	49(35)	36	17	11(48)	37(23)	64(70)	54(40)	79(87)
Young fledged per breeding pair[4]	1.58	1.60	0.68	1.22	1.90	1.37	1.29	0.63	0.94	0.28

[1]Breeding pairs laid eggs; nonbreeding pairs did not.

[2]Mean clutch and brood sizes include nests off the 162-km² study area, but within 40 km. There were 4, 1, 24, 10, 15, 8, 15, and 16 off-study-area clutches in 1966–1968 and 1971–1975, respectively; and 5, 5, 18, 9, 23, 10, 14, and 13 broods. Total nestling mortality (%) equals 100 times the complement of the product of the two-interval survival rates: thus for 1969 total mortality was 100 [1 – (0.89) (0.72)] = 36.

[3]Mortality rates shown in parentheses are for 18, 11, 24, 11, 13, and 13 off-study-area broods in 1968 and 1971–1975, respectively.

[4]Includes nests off the 162-km² study area.

fell out again, and the third was cannibalized by a sibling which later starved. In 1975, 15 of 18 (83%) dead nestlings died during a single 32-h period of heavy rain, high wind, and low temperatures. In an earlier year, 1972, 8 of 12 deaths had occurred within 1 wk of a heavy rainstorm. The immediate causes of death were thus notably different between years.

We determined pre-tethering losses among nestlings in nests situated off the study area during 6 of 10 yr (Table 3). In no single year did such losses on and off the study area differ significantly, but the overall averages of 44 and 32%, respectively, were different ($P < 0.05$). We suspect that our more frequent intrusions adversely affected brooding and feeding of young at study area nests. On the other hand, as discussed in a later section, mortality during the tethering period (age 5 to 8 wk) on the study area averaged significantly less ($P < 0.05$) than untethered young elsewhere (i.e., 15 vs. 30%). The end result of these time- and area-specific differences in mortality was a similar mean rate of loss over the entire nestling period of about 50% on both areas

Dietary Responses to Changing Hare Densities

Food Habits

Snowshoe Hares, Richarson's Ground Squirrels, and waterfowl constituted between 59 and 89% of the weight of food for young Red-tailed Hawks at Rochester each year (Table 4). The remainder consisted of a variety of small- to medium-sized mammals and birds, of which Franklin's Ground Squirrels *(Spermophilus franklinii)*, voles and sometimes grouse were important.

Snowshoe Hares were the dominant food of redtails during 1970–1973. Their peak use in 1970–1971 reflected the hawks' strong functional response to increasing hare densities (McInvaille and Keith 1974). During the next two years hare densities declined sharply, but there was a notable lag in the redtails' functional response to declining hare numbers. The concomitantly low ground squirrel population (Table 2) may have been partly responsible for this lag. By 1974, however, hares were near their cyclic low, and ground squirrel densities were the lowest we recorded; redtails then switched to waterfowl, which became the most important single food item, comprising 36% of their diet

Consumption of Richardson's Ground Squirrels was lowest (10% biomass) during 1972, coincident with continued heavy utilization of hares and a sharp decline in the ground squirrel population (Tables 2 and 4). By 1975, with hare densities at their cyclic low and ground squirrel

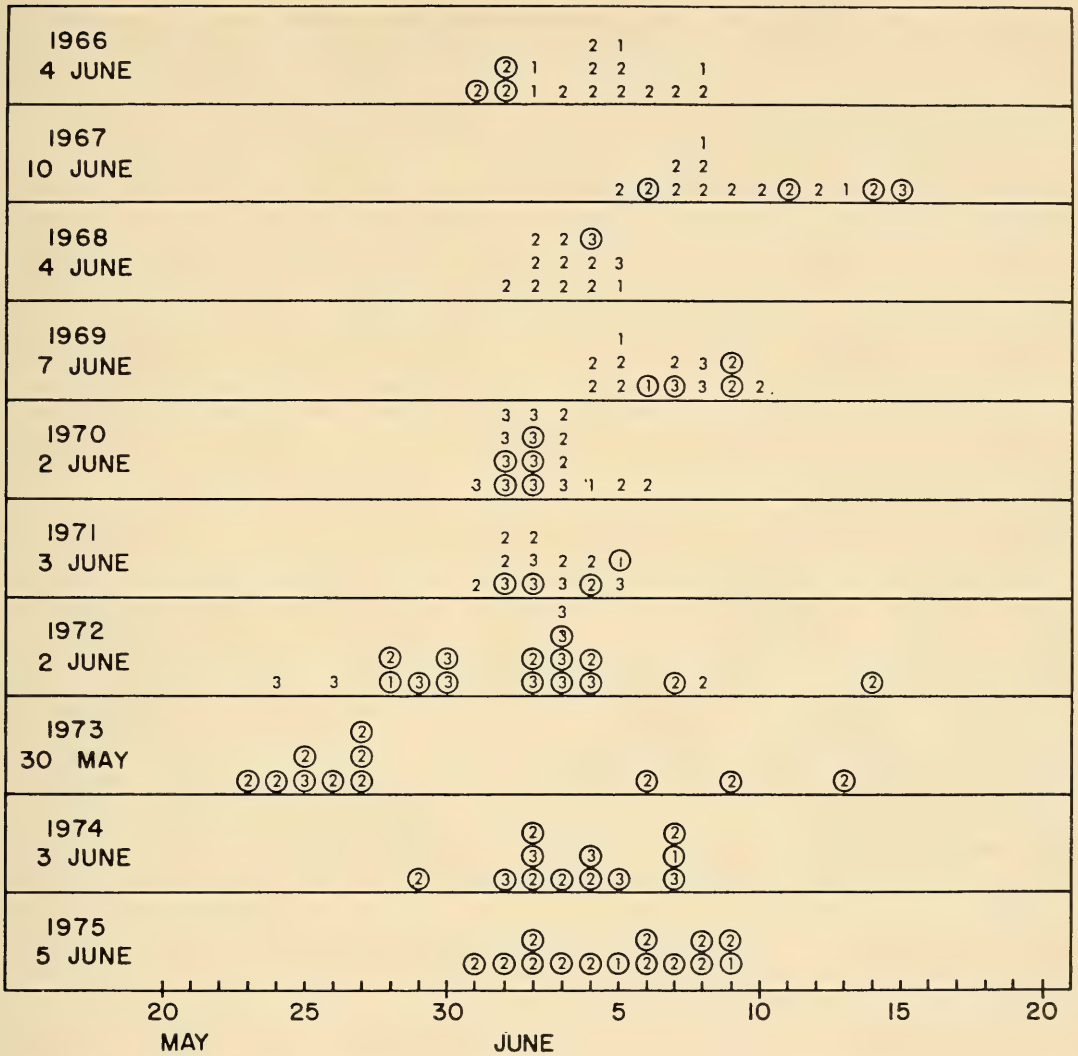

FIGURE 1. Annual distribution of Red-tailed Hawk hatching dates on the 162-km² study area near Rochester, Alberta. Dates of hatch of 63 to 84% (mean 72%) of study-area nests were determined yearly. Circles indicate nests first visited during incubation and/or within 1 wk after hatching. Mean date is given at left.

densities up four-fold, ground squirrels comprised 40% of the redtails' diet.

Biomass of Prey Brought to Tethered Young

The amount of food supplied to tethered nestlings varied significantly ($P < 0.01$) between years (Table 5). During 1966–1971, the mean daily biomass of prey per brood rose steadily from 345 to 768 g, while that per individual young increased more irregularly from 212 to 444 g owing to annual differences in brood size. Between 1971 and 1973, the amount brought daily to broods and individual young declined by 66 and 48% to means of 260 and 231 g, respectively, and remained low through 1975. Eighty-nine and 86% of the foregoing annual variation for broods and individual young, respectively, was attributable to changes in mean daily biomass of Snowshoe Hares in the redtail diet.

Annual utilization of hares was a direct function of their densities: regressions of mean daily biomass on total hare population estimates (Table 2) yielded coefficients of determination

TABLE 4 — Spring-summer (1 June – 31 July) food habits of nestling Red-tailed Hawks near Rochester, Alberta[1]

	Percent frequency										Percent biomass									
Prey species[2]	66	67	68	69	70	71	72	73	74	75	66	67	68	69	70	71	72	73	74	75
Snowshoe Hare	2	4	7	6	14	21	12	9	tr[3]	0	8	17	24	21	46	52	45	39	4	0
Richard's Ground Squirrel	21	13	25	22	32	26	6	11	7	14	42	25	34	39	38	28	10	23	25	40
Franklin's Ground Squirrel	4	5	6	4	tr	3	3	2	2	2	5	7	7	5	1	3	5	4	7	6
Voles and mice	32	41	13	34	40	30	36	42	44	23	5	6	2	5	4	2	4	6	10	4
Other mammals	7	10	16	13	1	5	6	7	6	25	6	8	8	9	1	5	4	5	8	24
Total mammals	66	73	67	79	87	85	63	71	59	64	66	63	75	79	90	90	68	77	54	74
Waterfowl	8	12	11	6	4	5	19	13	24	14	17	27	11	11	5	7	20	17	36	19
Ruffed Grouse	2	1	6	3	2	1	1	1	tr	0	2	1	5	4	3	1	2	2	tr	0
Sharp-tailed Grouse	1	1	1	1	1	1	tr	0	0	0	2	2	2	1	1	1	tr	0	0	0
Unidentified Grouse	1	1	0	1	0	1	tr	0	0	0	4	2	0	2	0	0	1	0	0	0
Other birds	23	12	15	10	6	7	16	15	16	21	10	5	7	3	2	2	8	5	10	8
Total birds	35	27	33	21	13	15	36	29	40	35	35	37	25	21	11	11	31	24	46	27
Totals[4]	101	100	100	100	100	100	99	100	99	99	101	100	100	100	101	101	99	101	101	101

[1]Total number of food items was 695, 1063, 585, 563, 879, 545, 1224, 387, 811, and 299 in 1966–1975; biomass total (in kilograms) was 167.2, 255.0, 199.9, 161.6, 298.9, 215.6, 308.0, 85.8, 107.5, and 47.6, respectively.

[2]Prey not specifically identified in the table were "Voles and mice": *Microtus pennsylvanicus* (average > 80% of small-mammal biomass). *Clethrionomys gapperi* (7%), *Peromyscus maniculatus* (4%), *Zapus hudsonius (1%), and Sorex cinereus* (tr); "Other Mammals": *Ondatra zibethicus, Tamiasciurus hudsonicus, Thomomys talpoides, Glaucomys sabrinus, Mustelafrenata, M.* nivalis, M. *erminea, Mephitis mephitis;* "Waterfowl": *Podiceps grisegena, Anas platyrhynchos, A. acuta, A. strepera, A. discors, A. carolinensis, A. americana, A. clypeata, Aythya americana, A. collaris, A. affinis, Bucephala albeola, Porzana carolina, Fulica americana;* and "Other birds": *Accipter cooperi, Falco sparverius, Perdix perdix, Charadrius vociferus, Columba livia, Colaptes auratus, Sphyrapicus varius, Picoides villosus, Perisoreus canadensis, Pica pica, Turdus migratorius, Sturnus vulgaris, Dendroica petechia,* and unidentified songbirds and domestic chickens.

[3]Less than 0.5.

[4]Insects and amphibians constituted less than 1% of the total biomass in all years.

TABLE 5—Weight of prey items brought to tethered nestling Red-tailed Hawks near Rochester, Alberta[1]

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Mean daily biomass (g) of food per brood										
Snowshoe Hare	28	77	121	122	289	399	229	101	14	0
Other prey species	317	375	383	457	340	369	280	159	331	316
Total (± SE)	345 ± 30	452 ± 45	504 ± 76	579 ± 114	629 ± 66	768 ± 80	509 ± 53	260 ± 23	345 ± 55	316 ± 48
Mean daily biomass (g) of food per individual										
Snowshoe Hare	17	47	92	68	174	231	170	90	10	0
Other prey species	195	229	292	257	204	213	207	141	228	173
Total (± SE)	212 ± 16	276 ± 30	384 ± 41	325 ± 51	378 ± 45	444 ± 38	377 ± 33	231 ± 28	238 ± 49	173 ± 23

[1]The number of tethered broods was 14, 15, 13, 11, 17, 12, 17, 7, 7, and 3 during 1966–1975, respectively. Prey biomass totals during 1966–1971 have been recalculated since the study by McInvaille and Keith (1974), using better estimates of mean prey weights; trends remained the same as reported in that earlier paper.

(r^2) of 0.89 and 0.79 for broods and individuals.

The above relationships reflect both the hare's periodic domination of the prey base, and the redtail's strong functional response to fluctuating hare densities.

Nest Distribution

Using Clark and Evans' (1954) nearest-neighbor test (see McInvaille and Keith 1974), we tested for randomness the spacing within annual nesting populations during 1972–1975. As in previous years, the distribution of redtail pairs on the study area was significantly ($P < 0.05$) regular, suggesting that territoriality continued to function as a spacing mechanism.

General Analysis of Factors Affecting Productivity

The most notable demographic change among Red-tailed Hawks from 1966 to 1975 was the lower fledging rate during the last 3 yr: viz., 0.62 young per breeding pair in 1973–1975 vs. 1.38 in 1966–1972. Although the main immediate reason for this decline was increased nestling mortality (Table 3), there were significant annual variations in mean date of nest initiation, and mean clutch and brood size, which might also have affected productivity. We therefore examined each component of productivity to determine what affected it and whether it interacted importantly with others to influence rates of fledging.

We considered the following demographic variables: (1) mean date of nest initiation (= start of incubation); (2) mean clutch and brood size; (3) hatching success; (4) nestling mortality to age 3–4 wk (pre-tethering); and (5) nestling mortality from tethering to age 7–8 wk. Where appropriate, and where data were adequate, we examined each of the above in relation to weather; prey density and/or biomass brought to young; and frequency of observer visits to nest sites during courtship, incubation, nestling, and tethering periods.

Mean Date of Nest Initiation

Mean date of nest initiation was analyzed in relation to weather factors and prey population levels through simple and multiple regression. Annual variation in mean date of nest initiation was not significantly related to percent days with precipitation, average daily precipitation, average snow depth, percent days with snow on the ground, or mean daily temperature during the courtship period. Nor was there any significant relationship between annual dates of nest initiation and spring densities of Snowshoe Hares, Richardson's Ground Squirrels, or previous-fall densities of mice and voles. Dates of nest initiation were likewise unrelated to various combinations of prey population indices and weather data.

Clutch and Brood Size, Hatching Success, and Nest Desertion

We initially suspected that weather conditions during courtship affected availability of prey and/or redtail hunting activity, and thus might influence clutch size. Annual variations in mean clutch and brood sizes, however, were unrelated to weather at Rochester. Years with largest clutches (1970, 1972, and 1974) had a broad spectrum of weather conditions during the courtship period (Tables 1 and 3). For example, 1970 and 1972 had mean daily temperatures during courtship of 5° vs. 2°C, rain or snow on 9 vs. 31% of the days, and snow depths of 9 vs. 24 cm. In 1966, when clutches were smallest, mean temperature and percent days with precipation resembled conditions in 1972, while snow depth was close to that in 1970. Additionally, we could find no correlation between clutch size and average daily precipitation or percent days with snow on the ground.

Although our data suggest that prey abundance may influence clutch size, the relationship was certainly not clear-cut. The large-clutch springs of 1970 (2.6) and 1974 (2.4) were each associated with high vole populations (McInvaille and Keith 1974; Table 2); hare and ground squirrel densities were also high in the first case but low in the second. In 1972, when clutches were equally large (2.6), adult hare densities were about 70% of those in 1970, adult ground squirrels about 30%, and voles were little utilized and probably scarce. The two springs in which mean clutch size was smallest, 1966 (1.7) and 1975 (1.9), were characterized by low hare and vole populations; we have no information on adult ground squirrels in 1966, but they too were low in 1975.

It is, of course, possible that conditions on winter ranges or during migration influence the size of redtail clutches. There was a positive and nearly significant correlation ($r = 0.60$, $P = 0.07$)

between annual dates of first arrival at Rochester and mean dates of egg laying, but mean clutch sizes were largely unrelated to the latter ($r = -0.34$, $P > 0.25$). The cause of major annual variations in mean clutch size probably resided on the breeding grounds since largest clutches occurred coincidently during 1970 and 1972 among redtails and non-migratory Great Horned Owls at Rochester (Adamcik et al. 1978).

In calculating rates of hatching and nest desertion prior to hatching, we excluded nest desertions attributable to climbing at the onset of laying or incubation. The significant between-year difference in hatching and desertion rates was entirely owing to data from 1968. In May, a major fire swept through part of the study area and likely prompted four nest desertions. Only 50% of all eggs hatched that year, and 6 of 19 (32%) active nests were abandoned prior to hatching. During the other nine years, hatching success averaged 92% (range 79 to 100%) and nest desertion only 6% (range 0 to 17%).

Pre-tethering Mortality

Pre-tethering losses of nestlings varied between years from 0 to 75% (Table 3). We analyzed such mortality through stepwise regression, in which the initial independent variables were mean daily temperature, percent days with precipitation, mean daily precipitation, mean numbers of days between our visits to nests, and mean prey biomass brought daily to tethered broods (expressed both as biomass per brood and per nestling). All statistics except the last were obtained during the pre-tethering period. The amount of food brought to young was measured during the tethering period, but we considered it also indicative of relative amounts provided before tethering. We chose a discriminant probability level of 10%, and constructed two separate models, one incorporating mean daily biomass of prey per tethered brood, the other per individual.

The above described regression analysis discarded mean daily temperature, mean daily precipitation, and our frequency of visits during the nestling stage from those models which best accounted for the annual variance in pre-tethering mortality. The resulting multiple regression equations and coefficients of determination were these:

(1) $Y_i = 3.88 + 1.36A_i - 0.14B_i$
$r^2 = 0.67$; $F(2,7) = 7.17$, $P < 0.05$

(2) $Y_i = 8.49 + 1.25A_i - 0.09C_i$
$r^2 = 0.73$; $F(2,7) = 9.49$, $P < 0.05$

where Y_i = estimate of pre-tethering mortality in year i;
A_i = percent days with precipitation during the nestling stage in year i;
B_i = mean biomass (g) of prey brought daily to individual tethered young in year i;
C_i = mean biomass (g) of prey brought daily to tethered broods in year i.

These models leave approximately 30% of the variance in early nestling mortality unaccounted for. We mentioned previously that Luttich et al. (1971) attributed higher tethering-period mortality in 1968 and 1969 to horned owl predation, and McInvaille and Keith (1974) suggested that such predation was buffered by the rising hare population in 1970 and 1971. A further horned owl kill, the first since 1969, occurred in 1972, when hares had declined sharply and owls were still abundant. Owl numbers fell rapidly during 1973–1975 (Adamcik et al. 1978), and no further predation on tethered redtails was observed. Losses to horned owls, either before or after tethering, would likely be independent of weather and biomass of prey brought to young redtails, and might thus account for some if not most of the remaining unexplained variance in our models.

Tethering-period Mortality

Variations in tethering-period mortality were irregular, and independent of weather factors, amount of food supplied by adults, or prey population densities. This contrast with pre-tethering mortality doubtless reflects an influence of our tethering methods, as two important causes of pre-tethering mortality, sibling aggression and exposure, were largely prevented by tethering. Tethered nestlings could not reach one another; and beginning in 1971, tethering sites were kept dry with a suspended plastic sheet. Thus losses of study-area young were probably minimum estimates of normal tethering-period mortality. This conclusion is supported by the fact that in 2 of 6 yr tethering-period mortality was significantly

lower ($P < 0.05$) on the study area than off (Table 3); and in at least 1 of the remaining years (1968), the main mortality factor was owl predation, which tethering did not prevent.

Discussion

Comparative Demography

Reported densities of nesting redtails have ranged widely from 1 pair per 1.3 km^2 in California (Fitch et al. 1946) to 1 pair per 39.5 km^2 in Utah (Smith and Murphy 1973). The mean of 1 nesting pair per 8.3 km^2 at Rochester over 10 yr was near that of 1 pair per 11.3 km^2 reported in nine studies, including the above two, during 18 yr (Craighead and Craighead 1956; Gates 1972; Hagar 1957; Johnson 1975; Orians and Kuhlman 1956; Seidensticker and Reynolds 1971).

Eleven percent of 188 pairs at Rochester did not lay eggs during 9 yr, 1967–1975. This was close to the 14% of 278 pairs reported on six other study areas during 13 yr (Craighead and Craighead 1956; Hagar 1957; Johnson 1975; Orians and Kuhlman 1956; Smith and Murphy 1973). Such lack of nesting applied to adults, i.e., birds almost 2 yr and older (Luttich et al. 1971), because in only two cases (Gates 1972; Luttich et al. 1971) were yearlings (brown-tailed individuals) paired. Each of these yearlings had mated with an adult.

The annual frequency of resident singles varied from 0 to 13% of the total Red-tailed Hawk population at Rochester. When concerted efforts were made in earlier studies to obtain a total census, unmated birds were likewise often found, but in variable numbers (Craighead and Craighead 1956; Fitch et al. 1946; Smith and Murphy 1973). The percentage of yearlings among singles apparently differs markedly between areas: all singles were yearlings in southern Michigan (Craighead and Craighead 1956), whereas none was at Rochester. Fitch et al. (1946) described the harassment of single birds by territorial pairs on a California study area, and it seems likely that a major portion of the yearling cohort may frequent localities where adult breeding densities are low but food is plentiful.

Henny and Wight (1972) calculated that maintenance of redtail populations was dependent upon a fledging rate of about 1.35 young per breeding pair. This calculation was based on the assumptions, among others, that the 22% nonbreeders reported in studies published through 1970 were yearlings, and that all adults nested. We have noted above that non-nesting occurs among adults, averaging 13% of 466 resident pairs. This is undoubtedly a conservative estimate since unpaired adults are also frequently present. Yearlings are so rarely a part of the paired resident population that they can be largely ignored as potential breeders.

Reduction of adult nesting from 100 to 87% increases the estimated required fledging rate from about 1.35 to 1.56 young per breeding pair. These calculations are particularly sensitive to errors in age-specific estimates of annual mortality. As Luttich et al. (1971) pointed out, first-year mortality may have been overestimated, thereby elevating the rate of fledging apparently needed for population maintenance. The stationary redtail population at Rochester, for example, fledged a mean of 1.38 young per breeding pair during the first 7 yr of our study. Although we may not know precisely the fledging rate that will balance the population, the much lower rate that occurred during the last 3 yr (mean of 0.62) was doubtless inadequate. In the absence of compensatory changes in survival and/or ingress, the earliest that such decreased productivity might have been detected by us was in 1975; but our population data are really insensitive in this respect, because an approximately 50% drop in fledging rate would theoretically reduce by only 2 the number of pairs present 2 yr later.

Henny and Wight's (1972) survey of redtail clutch sizes implied east-west and south-north gradients of increase. Their mean of 2.9 for 20 nests in southern British Columbia, Alberta, and Saskatchewan was among the highest noted. Our data from Rochester do not fit this model. Annual means recorded by us ranged from 1.7 in 1966 to 2.6 in 1970 and 1972 (Table 3); and the overall average of 2.2 during 1966–1975 was comparable to the lowest regional means shown by Henny and Wight. Our egg counts, conducted only once during incubation and at no consistent stage, provided an estimate of mean clutch size over the incubation period; consequently, they may be biased low if partial losses or clutches occurred before hatching. We suspect, however,

that most earlier studies of redtails were similarly biased.

Factors Affecting Nestling Survival to Age 3–4 Weeks

Fluctuations in nestling mortality influenced annual productivity of redtails at Rochester more than did all other demographic variables. About 70% of the variance in pre-tethering mortality was jointly attributable to frequency of rainfall and amount of food provided by parent birds. These two factors are not likely independent, because redtail hunting activity, and probably hunting success, were reduced by rain. The amount of food brought to nestlings was, of course, also affected by prey densities.

Direct adverse effects of rain on survival of nestling redtails was earlier observed in California (Fitch et al. 1946) and New York (Hagar 1957), but not among Red-shouldered Hawks (*Buteo lineatus*) in Maryland (Henny et al. 1973) or Buzzards (*Buteo buteo*) in England (Tubbs 1974). Several times at Rochester entire broods were found dead, wet, and abandoned after heavy rains.

Although it was not always possible to isolate the individual roles of inclement weather and low prey densities in nestling mortality, we could at least identify situations where malnutrition rather than exposure per se appeared mainly responsible. We conclude that emaciation, cannibalism, and most falls from nests were largely symptomatic of food shortage. An unknown but substantial portion of total disappearances was probably also caused by cannibalism and falls, and thus likewise ascribable to food shortage. From the above, we estimate that approximately 50% of pre-tethering losses resulted directly or indirectly from a shortage of food.

Reproductive Strategy of Northern Redtails

Luttich et al. (1971) noted that breeding populations of arctic- and temperate-zone raptors responded differently to changes in prey densities. The former, largely dependent on widely fluctuating microtines, are highly mobile and annually concentrate in areas where lemmings and voles have attained temporary abundance. Temperate-zone raptors, on the other hand, exploit a much more diverse and stable prey base, and local breeding populations of these raptors are often remarkably stationary from year to year (see recent summary by Newton 1976, p. 280). Newton (1976) concluded that, where nest sites are not limiting, regional differences in breeding densities of diurnal raptors reflect differences in average levels of prey abundance. This apparent adjustment to the food resource that usually prevails is sometimes inadequate, for as Craighead and Craighead (1956, p. 226) observed, "There are many examples of hawks and eagles returning to previous nesting territories and attempting to raise broods where there was not sufficient food to support them."

Redtail breeding populations are distributed throughout most wooded regions of the United States and Canada south of the tundra. As a predator, this raptor is a generalist, taking a great variety of prey. One might thus expect that it seldom experiences food shortage. Our studies at Rochester suggest, however, that this may not be true for northern redtails occupying habitats in which Snowshoe Hares are strongly cyclic.

We estimated earlier, for example, that malnutrition caused about 50% of the nestling losses within 3–4 wk after hatching. We concluded too that approximately 70% of the annual variance in such mortality could be attributed to differences in the biomass of food supplied to nestlings and the frequency of rain. The former was largely determined ($r^2 = 0.89$) by the biomass of Snowshoe Hare, which was in turn largely determined ($r^2 = 0.89$) by hare population densities.

Despite the fact that their prey base has a major cyclic component, breeding populations of northern redtails exhibit the same numerical stability and reproductive persistence that characterizes redtails and other temperate-zone raptors further south. The lack of any notable reproductive response to changing hare densities suggests to us that reductions in food during hare declines become critical to nestling survival only when associated with above-average rainfall after hatching. The latter is a *post facto* random event for which an accommodating reproductive strategy could not likely evolve.

In contrast, Great Horned Owls at Rochester have a breeding strategy that is clearly adapted to the hare cycle (Adamcik et al. 1978) and differs sharply from the evident constancy of

reproduction among horned owl populations further south. As McInvaille and Keith (1974) noted, northern horned owls unlike redtails, "... are year-round residents, subject to the stresses of cold and potential food-shortage during winter. When hares and grouse are scarce there are few alternative and available prey species. Most small-mammal activity is subnivean, and there is a paucity of overwintering songbirds."

Under these circumstances, cyclic lows in hare populations are certain to affect the owls' physical and/or physiological condition and hence their rate of breeding in late winter (March). When Snowshoe Hares were scarcest, as in 1974 and 1975, horned owls at Rochester laid no eggs, whereas during the 1968–1972 period of moderate-to-high hare populations all pairs produced and incubated a clutch. Such variable reproduction combined with appreciable ingress and egress generated a four-fold change in numbers of resident pairs over the 10-yr cycle of the hare (Adamcik et al. 1978).

The population dynamics of horned owls in the boreal forest ecosystem thus resemble those of arctic raptors (high mobility, conspicuous density, and reproductive changes), while breeding populations of northern redtails retain the characteristic stability of temperate-zone raptors.

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The Oriskany Sandstone Outcrop and Associated Natural Features, a Unique Occurrence in Canada

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An unusual type of oak-hickory forest not reported previously in Ontario has been found growing on sandstone in the southern part of the province. The sandstone is the middle Lower Devonian Oriskany Formation (approximately 380 million years old), a unit which crops out to no significant extent anywhere else in Canada and is found only to a very limited degree in the subsurface. This highly fossiliferous outcrop has a total areal extent of less than 250 ha (1 mi^2), most of it either under a thin cover of sandy soil or exposed as actual outcrop. Although the site is very dry it is unusually rich in plant species composition; at least 40 tree species grow in the area including an unusually large representation of oaks. There is an unexpectedly large number of understorey species for a dry forest. Some species in the understorey are more northerly elements that are quite uncommon in southern Ontario; others are southern species which are rare throughout their range in Ontario. A number of prairie associates are present as well. Twenty-two of the plants are rare in Ontario. The site serves as habitat for *Elaphe obsoleta obsoleta* (Black Rat Snake), one of the largest species of snake in Canada, whose southern Ontario populations are declining.

Key Words: Oriskany, sandstone, oak-hickory forest, big-shell community, brachiopods, Black Rat Snake.

The objective of this paper is to outline some of the outstanding natural features of the Oriskany outcrop in southern Ontario. The biologically important aspects of the site, which have been identified only recently, are in imminent danger of being lost owing to quarrying by the Flintkote Company of Canada. An "environmental protection area" has been selected by the company and will remain under company ownership, but it contains little of biological significance. Quarrying of the area is recommended by the Ontario Municipal Board and approved by the Ontario Ministry of Natural Resources. Zoning by-laws were modified in June 1978 to permit aggregate extraction at the Oriskany site, although the Regional Municipality of Haldimand-Norfolk now designates it as an environmentally unique ecological area.

Geology

The Oriskany Formation occurs to a very limited extent in southern Ontario but in no other part of Canada. A number of small outcrops of Oriskany sandstone are indicated on older geological maps (Stauffer 1915; Caley 1940) but just one, the largest of these, has been verified as Oriskany using modern petrographic criteria (J. F. Cowan, 1977, unpublished data, University of Western Ontario). Only the one authenticated exposure is shown on recent maps (Sanford 1969; Hewitt and Liberty 1972; Telford 1975). This outcrop of flat-lying sediments, located about 3.0 km NE of the village of Nelles Corners, Regional Municipality of Haldimand-Norfolk, Ontario (42°56′N, 79°57′W) is shown as an irregularly shaped area with an average diameter of approximately 1.5 km. Air photos and field observations, however, reveal that the outcrop is actually even more limited than the recent maps suggest. The greater part of the formation does not occur as an actual outcrop, but is covered either by the younger Bois Blanc Formation or glacial till. Figure 1 shows an estimate of the areal extent of the outcrop at the surface and in the subsurface. This sketch was drawn on an air photo base using observations made by ground reconnaissance.

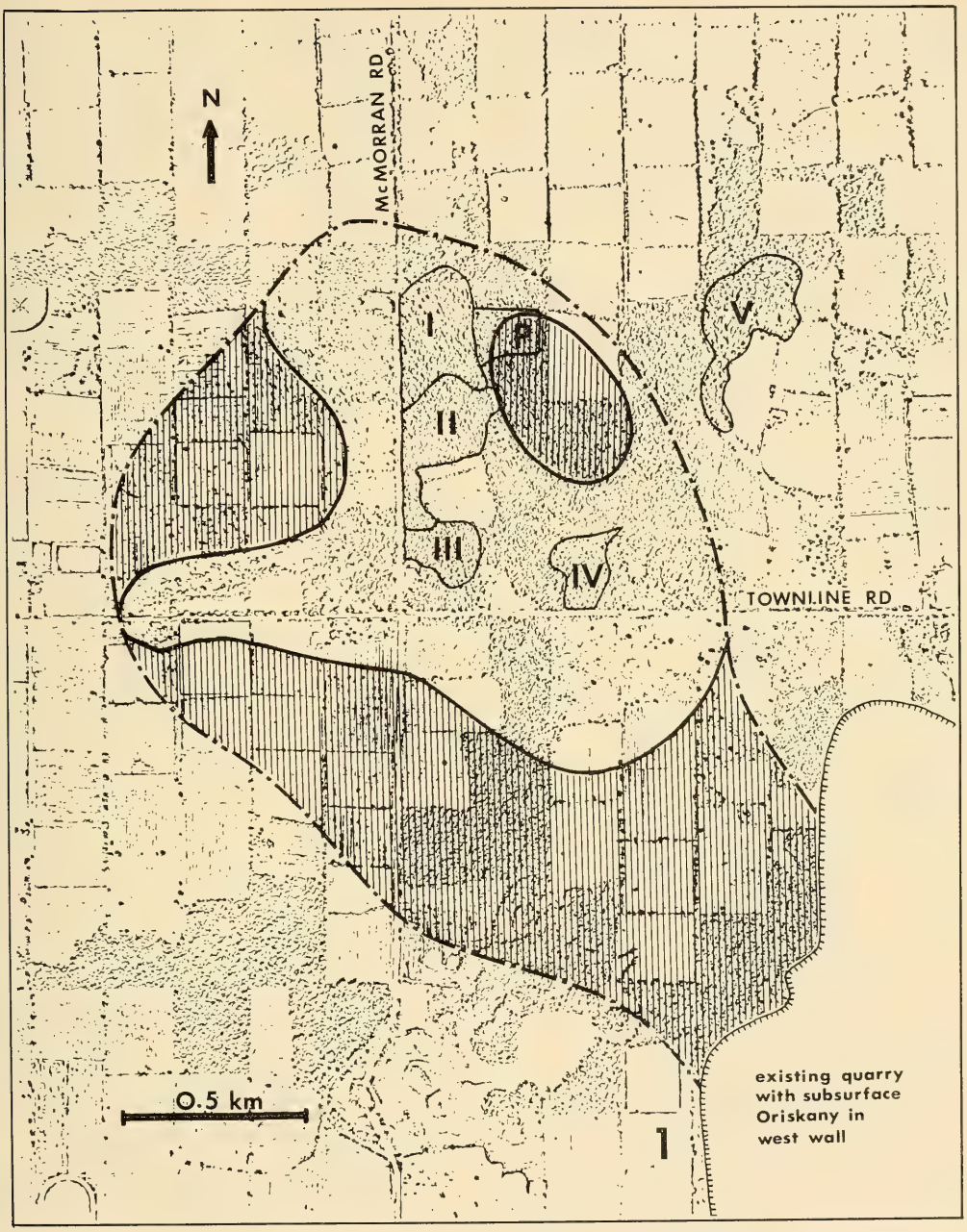


FIGURE 1. Sketch based on an air photo showing the Oriskany outcrop area near Nelles Corners, Ontario. Estimated limits of Oriskany sandstone in the subsurface are shown by a broken line. Vertical hatching represents Oriskany overlain by the Bois Blanc Formation; the unhatched portion represents Oriskany at the surface or directly under the soil. The locations of study sites I–IV (Tables 1 and 2) are indicated, as well as the open prairie area (P).

There is one unmapped occurrence of authentic Oriskany at "Shoap's Farm" about 2.4 km SE of Springvale, Ontario (42°57′N, 80°97′W) (Parks 1913), which consists of a vertical face only a few metres in length. As it has no horizontal exposure, it reveals only limited geological information and has little influence on native plants growing on the surface. Thus, the small Springvale outlier is of relatively little significance.

The Oriskany sandstone outcrop near Nelles Corners is a flat-lying erosional remnant which is now separated by a distance of 100 km from the edge of the continuous Oriskany in the subsurface south of Lake Erie (Figure 2). The type locality is at Oriskany Falls, southwest of Utica, New York. The New York correlation chart (Rickard 1975) shows the formation as part of the Deerparkian Stage (or the Siegenian, in European terminology) which is middle Lower Devonian or in absolute terms, about 380 million years old. This is an exceptionally coarse-grained sandstone consisting mostly of quartz with some feldspar. The quartz grains are well rounded and closely packed with a minimum of cement, which near the top of the formation may be calcite. The degree of cementation is variable and the rock tends to be friable at the surface where the rock is subject to frost action. The unit is very massive occurring in beds

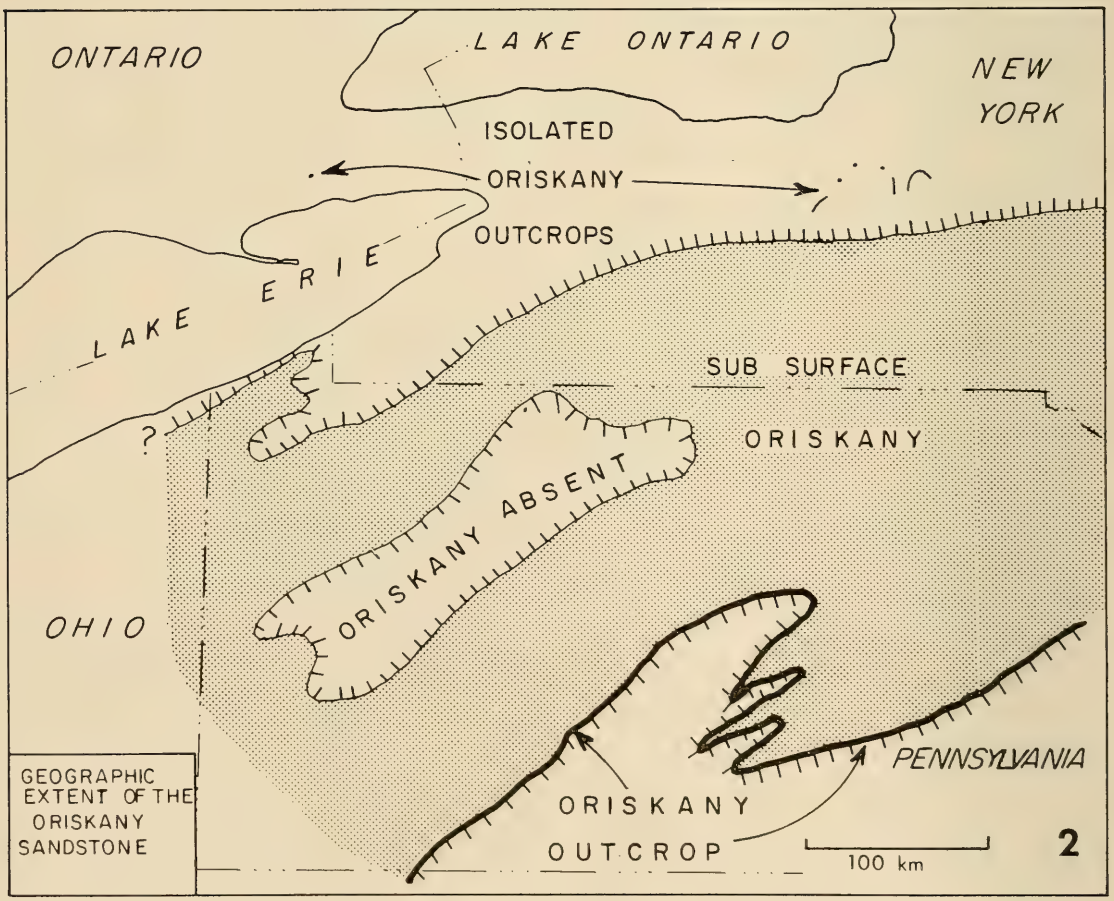
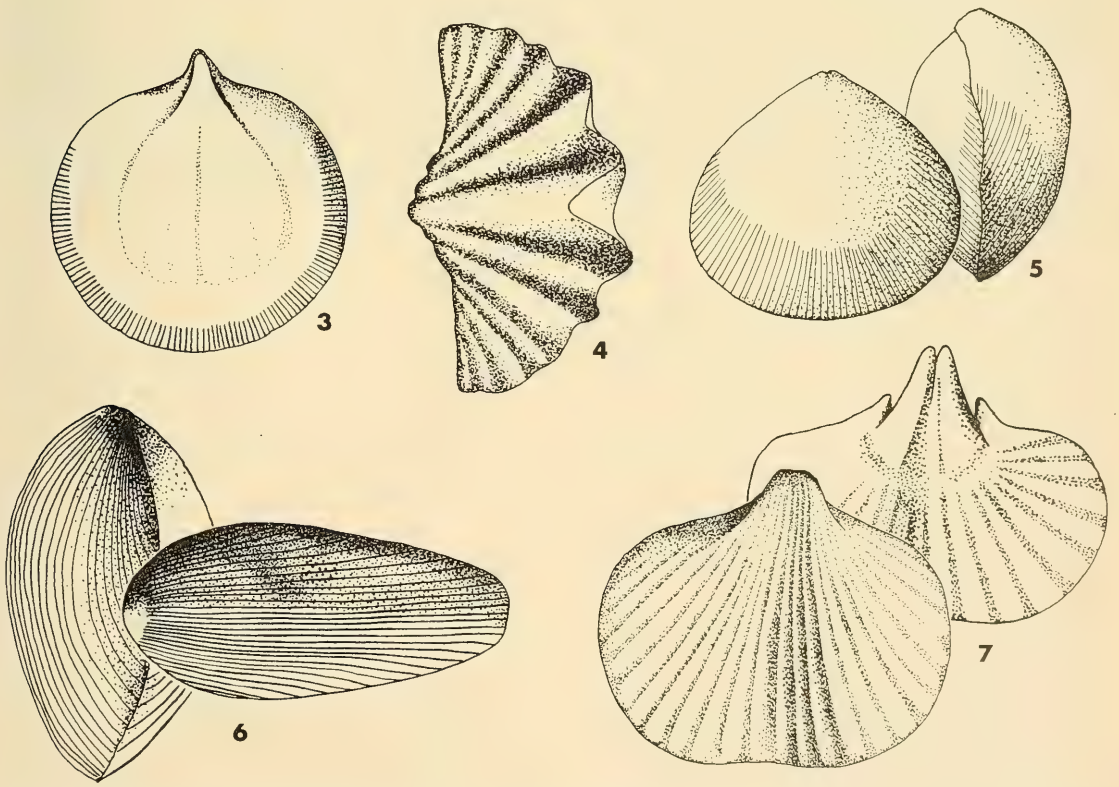


FIGURE 2. Geographic extent of the Oriskany Sandstone Formation. The stippled area represents Oriskany in the subsurface south of the Great Lakes. Isolated erosional remnants are indicated where they crop out in New York State and Ontario. Constructed from Rickard (1975), Kreidler (1964), and Lytle (1964).

up to 100 cm thick, which break out in large blocks along vertical joint planes. The rock is porous but rain falling on the surface runs laterally and disappears down joints or passes through to the underlying Bass Islands Formation. The permanent water table is 16–20 m below the surface. The imminent quarrying operation would be carried out above the water table.

Although fossil preservation is rather unusual in a coarse sandstone, parts of the Oriskany are highly fossiliferous. There are internal as well as external molds which show both interior and exterior characters of the shells. Fossils at the Nelles Corners site have been identified by Stauffer (1915), Caley (1940), and Best (1953) and include brachiopods, corals, trilobites, gastropods, pelecypods, and miscellaneous forms. Index fossils characteristics of the Oriskany sandstone include *Acrospirifer, Costispirifer, Hipparionyx, Rensselaeria,* and *Oriskania* (all brachiopods) (Figures 3–7). Some genera can be found in both North America and Europe (e.g.,*Acrospirifer*), and others are reported only from eastern North America (e.g., *Hipparionyx*). The large brachiopods that dominate the fossil fauna and are referred to as a "big shell community" (Boucot and Johnson 1967) are not found in any other Canadian sandstone. Of the more than 75 fossil species reported, only about one third occur elsewhere in Ontario or Quebec.

Unconsolidated rock materials over the outcrop are mainly of glacial origin and are either nonexistent or very thin. The site is therefore not suitable for agriculture and is largely covered by open woods known locally as the Clanbrassil Forest. The biological significance of the area was not realized until relatively recently.



FIGURES 3–7. Index fossils characteristic of the Oriskany Formation. 3, *Hipparionyx*; 4, *Acrospirifer*; 5, *Oriskania*; 6, *Rensselaeria*; 7, *Costispirifer*.

Vegetation

The first indications that the vegetation was in any way unusual were the observations of F. S. Cook (University of Western Ontario, personal communication 1976) who noted the presence of saxicolous mosses which are rarely seen in southern Ontario because their required substrate is essentially unavailable. Outcrops most common in southern Ontario are associated with the Niagara Escarpment and they are mainly limestone and dolostone. These rocks differ markedly from sandstone in their calcium content, the pH of materials derived from them by weathering, and their suitability for certain kinds of plant growth.

Open oak-hickory forest growing on sandstone bedrock is very unusual for Ontario. In order to develop a precise idea concerning the structure and composition of the forest, the vegetation was examined in detail and part of the area was sampled quantitatively.

Methods

Five homogenous areas ranging in size between about 2 and 6 ha were selected. Four were forested and one was an opening within the forest. A list was compiled of all trees, shrubs, and herbs in each forested area. Two of the larger areas were sampled quantitatively using the Point Quarter Method (Curtis 1959); 30 sampling points were scattered at random throughout each site. Around each point four trees and four saplings were randomly selected in each of four quadrants, i.e., the nearest specimens to the center point in each quadrat were selected. At every other point a sample of the ground layer was taken by recording presence (frequency) in metre-square quadrats. A number of environmental features as well as additional structural and compositional details of the vegetation were recorded when the sampling procedure was completed.

A frequency value was determined for each tree species on the basis of its percentage occurrence at points. These values were summed for all tree species and the contribution of an individual species to that sum was calculated as a percentage (= relative frequency). Similarly, the number of stems contributed by a species at points of occurrence was calculated as a percentage of the contribution of all species at all points (= relative density). The total basal area for one species was calculated as a percentage of basal area for all species (= relative dominance). The three values for a given species, relative frequency, relative density, and relative dominance, were combined to give its importance value. This is a precise measure of the ecological influence of a tree species in the forest.

In the forest openings lists were taken of all vascular plants present, and general observations on community structure and environmental features were recorded.

Parts of the outcrop along Townline Road (Figure 1) were badly disturbed with old foundations, old buildings, small abandoned quarries, and road systems. Because much of the associated vegetation was weedy, it was not examined in the same way as other sites within the general area.

Results and Discussion

Open oak-hickory communities (Figure 8) of the type located near Nelles Corners on sandstone bedrock had not previously been found during an extensive survey of forest vegetation of southern Ontario (Maycock 1963). At least 28 different tree species are found in the stands sampled on the Oriskany outcrop area (Table 1). This is considerable diversity for such a poor dry site.

At Site I (Figure 1) where the soil is very shallow there are no clear-cut dominants but *Quercus velutina* (Black Oak), *Q. rubra* (Red Oak), *Prunus serotina* (Black Cherry), *Quercus alba* (White Oak), and *Carya ovata* (Shagbark Hickory) are the major tree species. The source of names used in the text and tables is Fernald (1950). All 28 tree species are found in Site I, but more than half of stand importance is accounted for by oaks which together have an importance sum of 163 (Table 1). In the sapling layer *Fraxinus americana* (White Ash), *Prunus serotina, Amelanchier arborea* (Serviceberry), and *Acer saccharum* (Sugar Maple) are well represented. All of the oaks are represented to a limited extent in the sapling layer (approximately 20% of sapling-density) but are less important here than in the tree layer. Hickory reproduction appears to be maintaining the status of this species. A rich assortment of tall shrubs is found including (listed in order of

FIGURE 8. Open oak-hickory forest on sandstone at the Oriskany outcrop in southern Ontario. The best of these stands are presently scheduled for quarrying by King Paving and Materials of Burlington, Ontario, a Division of the Flintkote Company of Canada.

decreasing dominance) *Cornus racemosa* (Racemose Dogwood), *Amelanchier arborea, Viburnum rafinesquianum* (Downy Arrow-wood), *Prunus virginiana* (Choke-cherry), and *Viburnum acerifolium* (Maple-leafed Viburnum). *Pyrus coronaria* (Wild Apple) is one uncommon species of note. *Amelanchier arborea* does not often attain tree sizes but in this stand there are a number of large specimens. There is also a rich tall herb layer which includes *Pteridium aquilinum* (Brake), *Solidago caesia* (Blue-stem Goldenrod), and *Aster sagittifolius* (Arrow-leafed Aster), and a low herb layer with *Carex pensylvanica, Galium aparine* (Cleavers), and *G. circaezans* (Wild Licorice). In total 108 species of herbs and shrubs are present. Lichens are uncommon in forests of the deciduous forest regions but both lichens and mosses are locally abundant in Site I.

Site II is immediately below Site I on a gradual south-facing slope and also has shallow soils. The dominant trees are Red Oak and White Oak with a lesser representation of Shagbark Hickory and Black Cherry. Black Cherry, Shagbark Hickory, and Red Oak are well represented in the sapling layer, while *Cornus racemosa* and *Prunus virginiana* are important elements in the shrub layer. In the medium-height herb layer *Solidago caesia* and *Geranium maculatum* (Wild Cranesbill) are found, and in the low herb layer are *Maianthemum canadense* (Two-leafed Solomon's-seal), *Carex pensylvanica,* and *Aster macrophyllus* (Large-leafed Aster). This is also a dry complex with considerable diversity including 24 tree species and 87 herbs and shrubs.

Site III is just south of Site II toward the bottom of the gentle slope. In Site III the

TABLE 1—Tree species growing in selected stands at the Oriskany outcrop area. Locations of the four sites are shown in Figure 1. Presence is indicated by plus signs and importance values (defined in text) for the two larger sites are given in parentheses

Species	Sites			
	I	II	III	IV
Acer nigrum (Black Maple)	+	+ (3)		
Acer rubrum (Red Maple)	+ (4)	+ (3)	+	+
Acer saccharum (Sugar Maple)	+ (9)	+ (18)		+
Amelanchier arborea (True Serviceberry)	+ (20)	+ (3)	+	
Carpinus caroliniana (Ironwood)	+ (3)	+	+	
Carya cordiformis (Bitternut Hickory)	+	+ (7)		
Carya ovata (Shagbark Hickory)	+ (21)	+ (21)	+	+
Celtis occidentalis (Hackberry)	+			
Crataegus chrysocarpa (Hawthorn)	+	+		
Crataegus sp. (Hawthorn)	+	+		
Fagus grandifolia (Beech)	+			+
Fraxinus americana (White Ash)	+ (17)	+ (1)	+	+
Juglans nigra (Black Walnut)	+	+		
Juniperus virginiana (Red Cedar)	+	+		
Ostrya virginiana (Hop-hornbeam)	+ (1)	+ (15)	+	+
Pinus strobus (White Pine)	+ (6)	+ (4)	+	+
Populus grandidentata (Large-tooth Poplar)	+ (11)	+ (6)	+	+
Populus tremuloides (Trembling Aspen)	+ (3)	+ (5)		
Prunus cerasus (Cherry)	+			
Prunus serotina (Black Cherry)	+ (43)	+ (19)	+	+
Pyrus coronaria (Wild Apple)	+	+		
Quercus alba (White Oak)	+ (26)	+ (78)	+	+
Quercus macrocarpa (Bur Oak)	+	+ (4)		
Quercus muehlenbergii (Chestnut Oak)	+ (4)	+		
Quercus rubra (Red Oak)	+ (48)	+ (86)	+	+
Quercus velutina (Black Oak)	+ (81)	+ (19)	+	
Tilia americana (Basswood)	+ (4)	+ (8)	+	+
Ulmus americana (White Elm)	+			
Total trees	28	24	13	12
Total herbs and shrubs	108	87	45	27
Soil				
pH	4.6–7.0	8.0	7.5	6.4–7.8
Depth A_1 (cm)	6	8	10	10
Depth B (cm)	13	10	48	18
Moisture	dry	dry–mesic	dry–mesic	mesic

unconsolidated surface soil is deeper (see Table 1) than in either Site I or II. White Oak and Shagbark Hickory are the two dominant trees and scattered Black Cherry is also found. In the sapling layer cherry and White Oak are well represented. Prominent tall shrubs are *Cornus racemosa* and *Viburnum acerifolium*, while herbs include *Aster macrophyllus, Carex pensylvanica, Galium aparine,* and *Potentilla simplex* (Old-field Cinquefoil). In total there are 13 tree species in Site III and 45 species of herbs and shrubs.

Site IV, like Site III, is on deeper soil. The dominants are Sugar Maple and Red Maple with some White Oak, White Ash, and Red Oak. This stand is heavily shaded and the saplings are mostly maple. The low shrub layer is very sparse and includes scattered *Viburnum acerifolium.* The only herbs are low and include *Carex pensylvanica, C. pedunculata,* and *Solidago caesia.* There are 12 tree species represented in Site IV and 27 herbs and shrubs. There are few mosses or lichens.

In the forest openings, common dominants are *Cornus racemosa, Danthonia spicata* (Poverty Grass), *Rhus typhina* (Staghorn Sumac), *Prunus virginiana, Desmodium canadense* (Canadian Tick-trefoil), *Hypericum perforatum*

(St. John's-wort), *Solidago canadensis* (Canadian Goldenrod), and *S. juncea* (Stiff Goldenrod). One of the openings (P in Figure 1) is of particular interest because of its high component of dry prairie elements, notably *Lespedeza intermedia* (Intermediate Bush-clover), *L. capitata* (Headed Bush-clover), *Polygala verticillata* (Whorled Milkwort), *P. polygama* (Polygamous Milkwort), *Desmodium paniculatum* (Paniculate Tick-trefoil), *D. rotundifolium* (Roundleafed Tick-trefoil), *D. dillenii, Galium pilosum, Linum vriginiana* (Virginian flax), *Andropogon gerardi* (Gerard's Beardgrass), *Monarda fistulosa* (Wild Bergamot), *Physalis heterophylla* (Variable-leafed Groundcherry), *Solidago nemoralis* (Woodland Goldenrod), *Panicum linearifolium* (Linear-leafed Panic Grass), and *Aster ericoides.*

The Oriskany outcrop is considered to be a drier-than-average site for southern Ontario. If sites in the province were ranked along a continuum according to water availability, the Oriskany outcrop would be the driest of those capable of supporting forest. The trees are rather widely spaced approaching a condition intermediate between forest and savanna. The open condition of the canopy results in high light intensities within the stand and permits reproduction of species such as Black Cherry, hickory and oaks, as well as heavy shrub and herb layers.

Populus grandidentata (Large-toothed Poplar) is one species found at the site that is usually characterized by a very shallow rooting system. Many of the dominants, however, are species able to form long tap roots. For example *Quercus velutina, Q. alba,* and *Carya ovata* all produce vigorous primary roots early in development enabling the seedlings or young saplings to withstand drought conditions. *Quercus rubra* is another species represented at the site that is capable of producing deeply penetrating tap roots (Fowells 1965). *Pinus strobus* (White Pine) typically produces just the vestige of a tap root but has several large laterals extending outwards and down (Fowells 1965). White Pine root systems have been shown to penetrate to a depth of 4.5 m (Brown and Lacate 1961).

Many trees and shrubs are first- or second-collection records for the Haldimand County which close gaps in the distributional patterns for species both east and west. Thus the site has phytogeographical significance.

In the Oriskany outcrop area, the favorable sites with deeper soil are definitely less diverse in tree species. On better sites more dominance is exerted by fewer species. Greater moisture, more favorable pH, and perhaps better nutrition contribute to this pattern of tree occupancy. Species diversity is much greater in sites with shallow soils (e.g., I and II). At these sites there are a number of major tree species but no clear dominants, and there are far greater numbers of shrub and herb species. Diversity is undoubtedly related to the great variety of microhabitat available for plants. Some rock surfaces are exposed, others are covered with thin soil. The soil depth varies and the shallower soils have a low pH due to sandstone and absence of carbonate rocks providing opportunities for acid-loving plants, conditions which are seldom available in southern Ontario.

The maple stand (Site IV) is on deeper soil and is representative of a type of vegetation very common in southern Ontario. The interesting species of the sandstone outcrop type are absent. The sites of most value botanically are very heterogenous at the ground surface, i.e., those with shallow acidic soil over sandstone. The age of older trees in the maple stand is approximately the same as the age of older trees in the other forested sites studied.

The openings adjacent to the forest stands have allowed the invasion of dry prairie elements, further adding to the diversity of the area. The high diversity indicates that there may be other unusual species or communities in adjacent areas. For example, the Dry Lake area nearby has an interesting assortment of thicket and seasonal meadow communities. *Quercus bicolor* (Swamp White Oak) is one uncommon species that has been found in the lowland fringes of Dry Lake.

One group of rare and notable plants occurring in the outcrop area consists of more northern species that are quite uncommon in southern Ontario, although they may be widespread northward, and the other is composed of southern species that are rare throughout their range in Ontario. Northern species such as Hairgrass (*Deschampsia flexuosa*) and Running

Clubmoss (*Lycopodium clavatum*) are without doubt present here owing to the sandstone substrate and are otherwise quite rare in southernmost Ontario. Because of its southern location, the site also contains a number of uncommon species that are members of the Carolinian flora of Ontario. This flora occupies the region directly north of Lake Erie to a sinuous line from Toronto through London to Port Franks on Lake Huron. Examples of such species in this area are Wild Crab (*Pyrus coronaria*), Black Walnut (*Juglans nigra*), Hackberry (*Celtis occidentalis*), and Chestnut Oak (*Quercus muhlenbergii*). In summary, the unique vegetational status of the area is complemented by the presence of a number of rare and interesting species. Twenty-two of the species found in the Oriskany outcrop area are among those that have been listed as rare by Argus and White (1977) (Table 2). It is most unusual to find such a large number of rare plants concentrated in so small an area.

Habitat for the Black Rat Snake

The presence of unusual forest associations and unusual understorey plants provides a particular habitat for wildlife. The most notable animal known to inhabit the Oriskany site is the Black Rat Snake (*Elaphe obsoleta obsoleta*), the largest species of snake in Canada. The Black Rat Snake is considered rare, threatened, or endangered in Ontario and Canada by several authors (Campbell 1969; Cook 1970a; Anonymous 1970; Froom 1972; Stewart 1974; Parsons 1976; Cook 1977; Gregory 1977).

Observations of *Elaphe obsoleta* at the outcrop were made by W. W. Judd (University of Western Ontario) in 1976 and J. Webber (Erindale College, University of Toronto) in 1977, and by at least four local residents during the past two years. Judd observed a snake at close range for about 1 min; Webber was able to sketch anatomical details from a distance of 2 ft. One local person observed many snakes (of varying sizes) simultaneously in the spring of 1977.

It should be noted that the combination of rocky terrain and extensive relatively undisturbed forested area such as that found at the Oriskany site constitutes ideal habitat for the Black Rat Snake. Knudsen (1955) stated that the Black Rat Snake inhabits areas that have an abundance of rocky areas and crevices, and from these sites they venture out into nearby agricultural lands. The snake is sometimes considered a forest species (Hay 1892; Morse 1904;

TABLE 2—Rare plants (Argus and White 1977) found at the Oriskany outcrop. Areas are those shown on Figure 1

Species	Common name	Area found
Asplenium platyneuron	Ebony Spleenwort	I
Panicum lanuginosum var. *praecocius*	Woolly Panic Grass	P
Carex laxiflora var. *gracillima*		V
Disporum lanuginosum	Fairy Bells	II
Polygonatum biflorum	Solomon's Seal	I,II
Juglans nigra	Black Walnut	I
Quercus bicolor	Swamp White Oak	V
Quercus muehlenbergii	Chinquapin Oak	I,II
Ranunculus hispidus	Stiffly-hairy Buttercup	I
Arabis canadensis	Sickle-pod	I
Prunus americana	Wild Plum	I,II
Desmodium rotundifolium	Round-leafed Tick-trefoil	I
Lespedeza intermedia	Intermediate Bush-clover	P
Linum virginianum	Virginia Flax	P
Viola pedata var. *linearíloba*	Bird-foot Violet	P
Thaspium barbinode	Meadow Parsnip	V
Vaccinium pallidum (V. vacillans)	Hillside Blueberry	I
Asclepias exaltata		I,II
Conopholis americana	Squawroot	I
Galium pilosum		I
Swertia caroliniensis	American Columbo	V
Aster pilosus		P

Wright and Wright 1957; Fitch 1963); Wright and Wright (1957) and Fitch (1963) both mention occurrences associated with oak-hickory forests. Nearly half of the location records for radio-implanted specimens (Fitch 1963) were in trees while others were in burrows, low vegetation, or buildings. At the Oriskany site approximately 300 ha (3 km^2) including the outcrop and immediately adjacent areas are considered suitable habitat.

In Ontario, there are now two main isolated ranges for the Black Rat Snake. The one in the Kingston – Rideau Lakes area is maintaining itself to some degree, but the range in southwestern Ontario is clearly discontinuous despite maps (e.g., Conant 1975) indicating a continuous range along Lake Erie. In southwestern Ontario, there are only a few small isolated locations which are considered by C. A. Campbell to be sites of Black Rat Snake populations. These with dates of sightings in parentheses are (1) Essex County: Point Pelee, Pelee Island (1977), (2) Kent and Middlesex County: Skunk's Misery (1968, 1974), (3) Haldimand-Norfolk Regional Municipality: the western part of the former Norfolk County (the main center of abundance) (1940–1978) and other locations including the Oriskany site (1976–1978), and (4) Niagara Region: Fonthill in the Shorthills area (1928–1976). Even at these locations the snakes are not abundant; they are threatened by agriculture and a multitude of other human activities. Clearly, the number of large snakes in southwestern Ontario is seriously declining, as is the available habitat. There is no evidence that the Oriskany population is continuous with others in Ontario. Further details on the Black Rat Snake in Ontario are in an unpublished report by C. A. Campbell (1977) entitled "The status of the Black Rat Snake *Elaphe obsoleta obsoleta* in Ontario and particularly in the Haldimand-Norfolk Region" (available from C. A. Campbell or D. Fahselt).

Fitch (1963) calculated that the home range of adults in Kansas is 12 ha for males and 9 ha for females. In Maryland, the average home range of *E. obsoleta* was estimated to be 18± ha (Stickel and Cope 1947). Small populations are always particularly vulnerable, so the entire forest and outcrop complex must be maintained in its present condition in order to maximize numbers. Restriction of habitat is listed as one of the three major factors contributing to the decline of *Elaphe obsoleta* (Cook 1970a, b).

General Discussion

Threats to the Area

As the area is unique and interesting in several ways it is useful to consider the impact of likely types of disturbances. First, there is abundant evidence that fires have occurred in the past. Second, it is obvious that exposed bedrock of this nature is an attractive commercial source of mineral aggregate.

(a) Fire

Certainly dry sites such as this are quite susceptible to fire. Within the area blackened stumps or charcoal in the soil are evident at various locations. Though some scattered trees are older than 90 yr, it is clear that neither the oak nor maple forest represents an advanced state of succession. Few of the trees are large, most having basal areas of 516 mm^2 (80 in^2) or less. Fire may be one of the factors responsible for maintaining the oak-hickory forest in its present secondary successional state; burning would permit oaks, hickories, and Large-toothed Poplar to persist and predominate. Young oaks and hickories, and to a lesser extent even mature trees, sprout vigorously after the tops are killed back to the ground by burning (Fowells 1965); and fire may help to perpetuate *Populus grandidentata* as well as some of the prairie elements. Periodic burning may be partially responsible for maintaining the present successional state of the stand and contributing to the diversity of the interesting plant species. Selective logging at the site may have produced a similar effect.

(b) Commercial quarrying

Beneath the Oriskany formation at the Nelles Corners site is approximately 15 m of dolostone, a calcium-magnesium carbonate (the Bass Islands Formation), which is desirable as aggregate for paving and building. Quarrying would remove the sandstone formation upon which the oak-hickory forest depends. The forest could not re-establish itself afterward on the freshly exposed rock surfaces of the quarry floor because soil chemistry and water availability would be

quite different. Also there would be cold air drainage into the quarry bottom. If commercial removal of dolostone does take place an excavation with sheer vertical faces would result and this would have adverse effects on any peripheral remnants of forest. The edge effect associated with a disturbance as drastic as quarrying would likely be much more pronounced in a dry area such as this than it would in a mesic site. The establishment of a preserve for the fossiliferous portion of the Oriskany outcrop would not have a sufficiently large geographic area to support the unique plant communities such as those in Sites I and II, nor would it be suitably placed to include them.

Another problem associated with a possible quarry operation would be the effects of windblown particulates. Dust reduces available light and in some cases reacts with water to form toxic solutions. Trees growing near a source of carbonate dust were reported to have reduced terminal growth (Manning 1971) or to be in a generally poor condition (Brandt and Rhoades 1972). Particulate interference with stomatal behavior seriously affects the diffusion resistance of leaves and changes the rates of gaseous exchange (Ricks and Williams 1974). This could aggravate moisture stress on sites that are exposed or dry (Smith 1974). The rates of degradation of photosynthetic pigments in the leaves of *Quercus petraea* were significantly changed owing to particulate pollutants (Ricks and Williams 1975) and senescence occurred earlier at the polluted sites. Leaves with moderate limestone dust deposits had a greater incidence of fungal leaf spots (Manning 1971), and plants dusted with cement-kiln dust were more susceptible to fungus leaf spot disease (Schonbeck 1960).

A numerical model which predicts the rate of dispersion of atmospheric particulates and the amounts of deposition in wooded areas was described by Belot et al. (1976). A forest canopy significantly increases the concentration of particulates deposited near the source. It is predicted that maximal deposition would occur within 1 km of dust-producing activities.

Tree species respond differentially to dust accumulation. Brandt and Rhoades (1973) have shown that while lateral growth of *Liriodendron tulipifera* (Tulip Tree) was increased as a result of deposition of dust from nearby limestone quarries and processing plants, *Quercus prinus, Q. rubra,* and *Acer rubrum* underwent a reduction in lateral growth. Therefore, in a mixed stand involving these species, importance values would be altered with time. In fact Brandt and Rhoades (1972) documented significant differences in the seedling-shrub and sapling strata between two comparable sites, one with a heavy accumulation of limestone from quarries and processing plants and the other a control area with no dust accumulation. The dominant species at the dusty site would therefore change with continued dust accumulation. The papers by Brandt and Rhoades indicate that it would be difficult to maintain a natural balance among tree species in a forest adjacent to a sustained source of heavy limestone dust.

It cannot be imagined that quarrying would have anything but a detrimental effect on *Elaphe obsoleta.* First, the snake is susceptible to roadkill (Fitch 1963). Second, it retreats with the advent of disturbance to wooded areas (Morse 1904; Minton 1968). Quarrying would lead to an obvious loss of suitable habitat.

Synopsis

We have emphasized the geological importance of the Oriskany Formation in Canada and provided some indication of the unusual nature of this forest tract and its richness in tree and other plant species as well as its unusual structural and compositional features. We have also attempted to show its value as a habitat for the Black Rat Snake. The Oriskany site represents the *only* example of oak-hickory forest on sandstone in Ontario. It is decidedly unique in representing a dry upland type of oak-hickory forest not recognized in Ontario. The oak-hickory type in Ontario is usually associated with heavy clay soils which have peculiar drainage and moisture features and never seems to approach a classical dry oak-hickory type as does the existing example at Nelles Corners. This feature coupled with the large number of unique and interesting plant occurrences, especially the unusually large number of oak species, combines to produce a natural area of great value and interest, and one which should

be given complete protection. Preservation of the entire area would be consistent with the adopted policy statement of the Canadian Institute of Forestry (Weetman 1972) that 123–410 ha (300–1000 acres) is a highly desirable size for forested natural areas. Interesting natural features, geological and biological, occur throughout the Oriskany outcrop area, so it is particularly crucial in this case that a large preserve be set aside.

The Flintkote Company has selected an "environmental protection area" of 19 ha (47 acres) to be located along Townline Road, the southern boundary of the quarry site. This selection has been approved by the Ontario Municipal Board and by the Ontario Minister of Natural Resources. The area does contain features of geological interest but, because of its very small size and the disturbances there, it is of virtually no importance biologically.

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Breeding Areas and Overnight Roosting Locations in the Northern Range of the Monarch Butterfly (*Danaus plexippus plexippus*) with a Summary of Associated Migratory Routes

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As a result of over 40 years of investigation dealing with the ecology of the Monarch Butterfly (*Danaus plexippus plexippus*), with special reference to its migratory habits, it is now possible to outline the major breeding areas in its northern range in Canada and to explain the absence of such areas in the western provinces. The characteristics of the overnight roosting clusters located along the migratory routes are described and compared to those of the overwintering clusters. A summary of the migratory routes for these northern populations is presented, based on previous published records for North America.

For the past 41 yr, commencing in the summer of 1937, we have been involved in a long-term study of the biology of the Monarch Butterfly, *Danaus plexippus plexippus* (Danaidae: Lepidoptera), with special reference to its migratory habits. Although most of our field studies and alar tagging (Urquhart 1941, 1960) have been centered in Ontario, observations have been made in all provinces from Vancouver, British Columbia to Cape North, Nova Scotia. These field surveys were for the purpose of investigating the presence, or absence, of breeding areas and, where adults were found, to alar tag them for migratory studies.

It is the purpose of the present paper to summarize our field data for the northern range in Canada, correlating this information with the migratory habit. Because the program has been carried out over a long period of time it has been possible to witness the change in the northern range of the Monarch Butterfly and the increase in its abundance where at one time larvae were unknown or of rare occurrence.

Methods

Field trips were carried out in various localities in each Canadian province and notes made concerning the presence or absence of milkweed plants (*Asclepias* spp.), the source of food for the larvae of the Monarch Butterfly, and of the larvae and adults of the Monarch Butterfly.

Members of the Insect Migration Association (IMA) sent observations concerning the presence of the larvae and adults of the Monarch Butterfly, together with notes as to their abundance in each area.

An alar-tagging program (Urquhart 1960, 1965; Urquhart and Urquhart 1976b) was carried out along with field investigations and by members of the IMA in order to follow the movements of the Monarch Butterfly.

Publicity arising from the recapture of alar-tagged specimens resulted in further observations being sent to us by interested individuals.

All observations and recapture data are on permanent file at Scarborough College, University of Toronto.

Results and Discussion

Breeding Range

Field surveys carried out from 1937 to 1940 indicated that breeding areas of the Monarch Butterfly in Ontario were mostly confined to the lower Great Lakes regions extending from Gananoque and Kingston in the east to Goderich in the west and south to Leamington. Large concentrations, owing to the presence of

dense growths of the Common Milkweed (*Asclepias syriaca*), were concentrated in the Sarnia-Leamington, Brantford-Hamilton, Toronto-Oshawa, and Belleville regions. Although larvae were collected further north at Barrie and Midland they did not occur in large numbers because growths of the Common Milkweed were not as dense as those found further south.

As a result of the increase in the number of roads and highways and the clearing of forested areas for power lines, the Common Milkweed has gradually spread northward thus increasing the amount of this host plant for the larvae. By 1975 records of large concentrations of both larvae and adults were reported from various locations along the north shore of Lake Superior, particularly at Sudbury, Sault Ste. Marie, and Thunder Bay. In the early summer of 1977 larvae were more abundant in the Sault Ste. Marie area than in the Toronto-Oshawa area; we had larvae mailed to our laboratory in Toronto from Sault Ste. Marie in order to carry out various research projects.

The reason for this difference in the numbers of Monarch Butterfly larvae in the Lake Superior regions in the early summer as compared to the Toronto-Oshawa area can be explained. We have previously shown (Urquhart and Urquhart 1976d, 1977) that Monarch Butterfly migrants travel in a northwesterly direction in the autumnal migration and northeasterly in the vernal. In this way the migrants reach the north shore of Lake Superior, via Michigan, before arriving in the Ontario peninsular regions. Since the Common Milkweed is now abundant in the Lake Superior regions larger populations of butterflies have occurred here in early summer than further south.

Field surveys each summer from 1962 to 1977 from Toronto north to the northeast shore of Georgian Bay disclosed increasing abundance of the Common Milkweed covering hundreds of hectares along roads, highways, and uncultivated fields. Also, as a result of the clearing of forested areas, with particular reference to power lines, ever increasing areas have been made available for the further spread of the larval food plant. One experimental plot of 0.5 ha located in a forested area, that had been cleared during lumbering operations, revealed a population of 536 larvae on 15 July 1977.

For other Canadian provinces records accumulated over the past 41 yr (including 4 yr of field investigations of 1940–1944 in the western provinces and surveys in the eastern provinces together with numerous reports from various interested individuals and members of the IMA) indicate conclusively that there are no breeding areas in British Columbia and Alberta. A few scattered larval populations have been reported for southern Saskatchewan (Duval) and southern Manitoba (Transcona, Furness). Although there have been numerous records of adults seen in Nova Scotia, New Brunswick, Prince Edward Island, and occasionally in Newfoundland, we have no records of any breeding populations there. Three reports have been received from Quebec (Montreal, Drummondville, Quebec).

The marked differences among the population numbers in the various provinces are due in part to the migration routes and in part to the distribution of the species of milkweed. Since the migration tends to a northeast–southwest direction from the overwintering Mexican Site (Urquhart and Urquhart 1976d) the migrants miss the western provinces with only a few stragglers being reported. Similarly, the eastern provinces are outside the regular migratory route. Although species of milkweed of the genus *Asclepias* are found in all provinces, except Prince Edward Island, Labrador, and Newfoundland, the majority of species are found in Ontario where *Asclepias syriaca* occurs in the greatest abundance. One species is reported for British Columbia (*A. speciosa*); there are no records from Alberta; six occur in Manitoba (*A. incarnata, A. verticillata, A. ovalifolia, A. syriaca, A. speciosa, A. viridiflora*); two occur in Saskatchewan (*A. ovalifolia, A. speciosa*); 10 occur in Ontario (*A. incarnata, A. verticillata, A. tuberosa, A. exaltata, A. quadrifolia, A. syriaca, A. sullvantii, A. purpurescens, A. hirtella, A. veridiflora*); two species occur in Quebec (*A. incarnata, A. syriaca);* one species is recorded from New Brunswick (*A. syriaca)*; and one species from Nova Scotia (*A. incarnata*).

From the above records of the distribution of species of the larval food plant and the direction of migration, it is obvious why there is by far the largest population in the northern range located in the province of Ontario.

Overnight Roosting Clusters

During the autumnal migration the Monarch Butterflies cluster on trees of various species along the migratory routes to remain during the night period (Urquhart 1960). Of the species of deciduous trees chosen Red Maple (*Acer rubrum*), Sugar Maple (*Acer saccharum*), Manitoba Maple (*Acer negundo*), and willow (*Salix* sp.) were most common. Pine (*Pinus* sp.) and spruce (*Picea* sp.) were most frequently chosen since it was possible for the butterflies to obtain a secure hold with the sickle-shaped tarsal claws (Urquhart 1960).

During periods of calm weather individuals of a cluster are widely spaced (Figure 1). During stormy conditions with strong winds the migrants cluster closer together and there are fewer clusters on the trees. The massing together under conditions of strong winds has the distinct advantage of causing the weighted branch of the tree to sway in the wind rather than being whipped about, which would dislodge the migrants. The leeward side is always chosen as a protection against the wind.

Since migrants tend to cluster on certain trees year after year, it has been thought that perhaps an odor of some kind may have been left the previous year thus acting as a guide for future generations of migrants. Numerous observations in many localities, however, have not produced evidence to substantiate such a suggestion. For example, when a particular group of roosting trees was removed, the migrants selected another group that had not been used previously. As has been demonstrated, the direction of migration, the presence of suitable

FIGURE 1. Overnight roosting Monarch Butterflies during the autumnal migration showing the widely scattered nature of the clusters.

trees en route located near nectar-producing flowers such as the Canada Goldenrod (*Solidago canadensis*) and the New England Aster (*Aster novae-anglia*), and topography are the factors determining the choice of roosting trees (Urquhart 1960).

Although overnight clusters may occur in numerous localities throughout southern Ontario, they are most abundant and composed of larger clusters along the north shores of Lake Ontario and Lake Erie. This is owing to the migrants' antipathy to fly over large bodies of water beyond sight of land; hence they move in ever increasing numbers along the lake shores (Urquhart 1960, 1966, 1976a).

The manner in which the migrants cluster on a particular part of the roosting tree or trees is as follows. The first arrival flies around the tree, testing wind direction and a suitable site upon which to land. Many tests are made before a final location is chosen. Having finally landed the butterfly opens the wings to display the more brilliantly colored dorsal surfaces. This acts as a beacon to others that in turn land and open their wings. If one migrant lands too close to one already at rest the latter snaps its wings in a warning gesture which acts as a further stimulus for others to land upon the particular branch. Eventually a cluster is formed.

When the migrants reach their final overwintering destination in the Neovolcanic Mountain site of Mexico (Urquhart 1976b; Urquhart and Urquhart 1977), they form dense clusters that are quite unlike those of the overnight roosts (Figure 2). Migrants on the overnight roosts, as mentioned previously, occur as small scattered clusters, the individuals widely spaced; they do not cluster on the trunks of the trees or upon adjacent bushes or upon the ground. In the overwintering clusters, the roosting trees are so densely covered that it is not possible to see the foliage of the trees; the trunks are also densely covered as well as the neighboring bushes. In some loci[1] the ground is also covered (Urquhart and Urquhart 1977: Urquhart and Urquhart 1976a, b, d, 1977). This difference between the two clusterings is due to the massed millions of migrants in the overwintering roosts as compared to the smaller clusters scattered over a wide area along the migratory routes.

Migratory Routes

The Monarch Butterflies migrate from the breeding areas in Canada mainly to Mexico where they overwinter in various loci in various mountain areas of the Mexican Site in the Neovolcanic Mountains, sometimes referred to as the "Cross Range" (Urquhart and Urquhart 1979).

Migrants from west of Lake Superior move SSW (190°); those from the north shore of Lake Huron move SSW (200°) and those from extreme southwestern Ontario move SSW (215°) (Figure 3, route D). Migrants from the rest of Ontario and western Quebec indicate two flight patterns. The greater number move SSW (200°) to the coast of the Gulf of Mexico and thence westward (270°) (Figure 3, route C) following the Gulf coast eventually towards the overwintering site (Figure 3, route E) on a trajectory SSW (195°). Others, perhaps as a result of strong westerly winds during the flight period, move SSE (110°) (Figure 3, route A) to the Atlantic coast. Following the coast line SSW (195°–210°) the majority reach the coast of the Gulf of Mexico where, following the coast line, they travel westward (Figure 3, route C). Others, representing a small proportion of the migrating population, termed an "aberrant" population (Urquhart 1976a, b; Urquhart and Urquhart, 1976c, 1977), move down the Florida peninsula SSE (140°), thence to Cuba and Yucatan SSW (240°) (Figure 3, route B) or, continuing SSE (120°–140°) become scattered over the islands of the Antilles. The final destination of this aberrant population is as yet unknown.

Vernal Migration

Vernal migrants leave the Mexican Site in late February and March (Urquhart and Urquhart 1979). Mating takes place at the site, when the clusters break up, and along the migratory routes as far as central Texas — males rarely proceed further. They enter the various Canadian provinces, especially Ontario, commencing in the last week of May through June and early July. During late June and early July second-

[1]*Site* refers to the geographic location of an overwintering site, such as the Mexican Site, the California Site, etc.; *Area* refers to a particular geographic location where a number of clusters are to be found, such as a volcanic mountain in Mexico or the Monterey Peninsula in California; *Locus* (i) refers to a particular location within an area where a cluster exists which may change from year to year, such as loci in an area in Mexico or in the Monterey Peninsula.

FIGURE 2. Overwintering roosting Monarch Butterflies on a tree in the Neovolcanic Plateau Site of Mexico showing the compact nature of the clusters completely covering the branches and trunks of one of over a thousand trees.

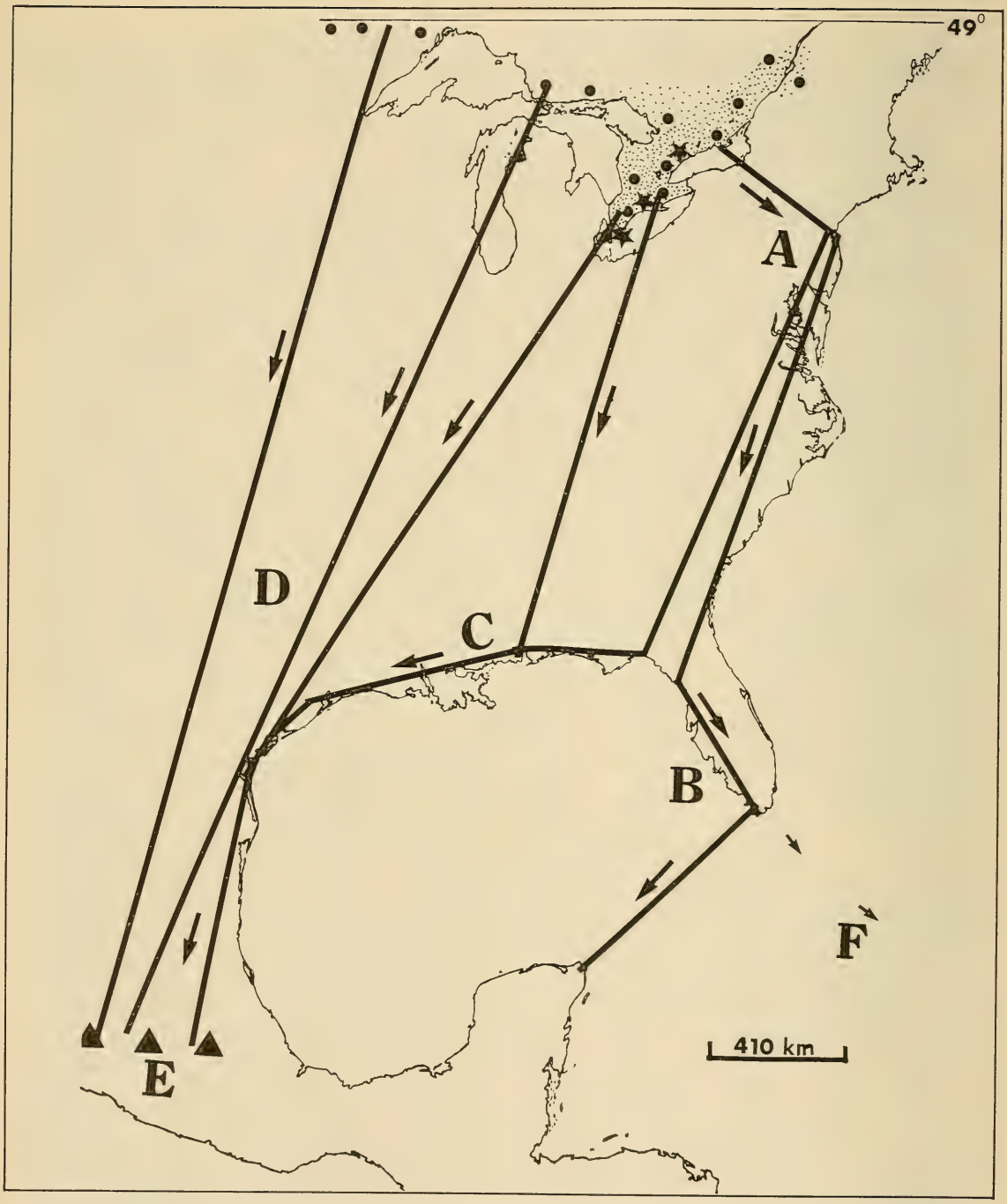

FIGURE 3. Migration routes of the Monarch Butterfly from the breeding areas in Canada to the overwintering site in Mexico and the aberrant migration routes to Yucatan and the Antilles. • breeding areas; ★ major overnight roosting areas; ▲overwintering site; ⟶direction of flight. A, flight pattern to the Atlantic coast; B, flight pattern through Florida to Yucatan; C, flight pattern along the north coast of the Gulf of Mexico; D, flight pattern from the western provinces, north of Lake Huron and southwestern Ontario; E, overwintering Mexican Site; F, possible flight direction towards the Antilles.

generation adults, resulting from eggs deposited on species of milkweed by migrating females, enter Canada. These are readily identified by their brighter coloration, those from the Mexican Site being decidedly faded with tattered wing margins (Urquhart 1966). First-generation adults from breeding areas in Canada appear from mid-July through August. A second generation occurs in the more southern sections from mid-August through September.

Autumnal migration commences in mid-August, the numbers increasing through late August and September and, under conditions of high temperature, through October. A few stragglers have been collected in November and three specimens during the first week of December. It is highly unlikely that these late migrants reach the overwintering sites.

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Reproductive Biology of the Big Brown Bat (*Eptesicus fuscus*) in Alberta

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Data on Big Brown Bat (*Eptesicus fuscus*) populations in Alberta were collected from 1972 to 1977 during surveys to determine the prevalence of rabies. The 60 maternity colonies located included 56 in older buildings; many of these sites were used as hibernacula. Most young were born during the latter part of June; parturition was estimated to extend from at least 5 June to 12 July. Fifteen of 115 pregnancies were twins. Ages of a sample of bats were determined by counts of dental annuli; those ages generally correlated with tooth wear. Yearling females had a lower pregnancy rate than older females.

Key Words: Big Brown Bat, life history, dental aging, Alberta.

The Big Brown Bat (*Eptesicus fuscus*) is relatively abundant and widely distributed over North America (Hall and Kelson 1959; Barbour and Davis 1969). Most studies of the species have been in eastern North America (Christian 1956; Brenner 1968; Davis et al. 1968; Barbour and Davis 1969; Kunz 1974; Mills et al. 1975) where the usual litter size is two. Comparatively few data are available for the species in western North America, particularly western Canada, where the usual litter size is evidently one (Cockrum 1955; Christian 1956; Kunz 1974).

A bat-rabies monitoring program in Alberta was prompted by the first diagnosis of a rabid bat in the province in 1971, and an outbreak of rabies among other animals in 1970 and 1971. Epidemiological results of this program have recently been presented by Dorward et al. (1977); biological data on *E. f. pallidus* in Alberta collected during the course of the study are presented here.

Methods

Colonies were located through the following means: complaints of bats relayed by governmental personnel and systematic surveys during 1971 to 1977; newspaper advertisements in 1971 and 1972; results of a questionnaire mailed to rural homeowners in 1973; and reviews of histories of rabies-suspect bats. Collections of 10 to 20 bats for rabies testing were made at a number of maternity roosts; larger collections were made at two maternity roosts and a fall roost, all of which were known to have harbored rabid individuals. Bats were collected within colonies by hand, forceps, and a modified Constantine trap (Constantine 1958); at colony exits by a variety of enclosure traps; and by mist-nesting away from colonies. Colonies were generally visited only once, although two or three visits per year were made to one colony to band bats. Available for analysis were 256 Big Brown Bats submitted as rabies-suspect individuals from 1974 to 1977.

Age (adult or juvenile) as determined by closure of the epiphyses of the fingers, and sex were noted for each bat. Reproductive status of adult females was recorded, as was the number and sex of fetuses of parous individuals. Ages of adult bats taken at two maternity roosts, a fall roost, and a sample of rabies-suspect individuals were determined from counts of dental annuli (Schowalter et al. 1978). The first of January was arbitrarily used as the date on which bats became a year older: thus a bat classified as a 1-yr-old was taken the summer after the summer of its birth. Tests for significance were by the simple chi-square test.

Results and Discussion

Big Brown Bats appeared to be more abundant in southern than central Alberta (Figure 1). We discovered 32 colonies in southern Alberta and 28 colonies in the larger area of central

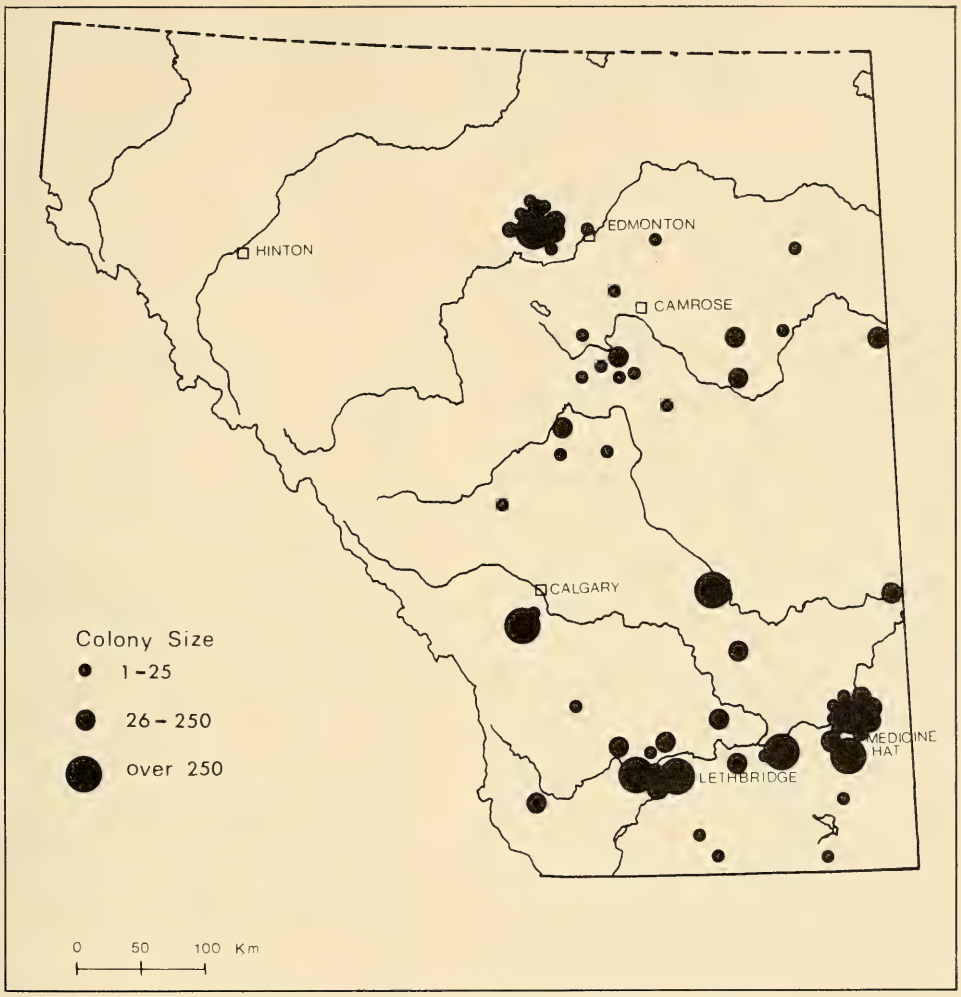

FIGURE 1. Distribution of known Big Brown Bat colonies in Alberta.

Alberta. Although estimates of the number of bats were approximate, colonies were evidently larger in the south, where the average number of adults was 80. In central Alberta average colony size was 44. Mist-net captures indicated that Big Brown Bats were relatively abundant in natural habitats along river valleys in the southern area of the province. Much of this apparent greater abundance in the south is related to the occurrence of maternity roosts in the cities of Medicine Hat and Lethbridge. We have seldom located maternity roosts of Big Brown Bats, or other species, in more northerly cities in Alberta. A search of 28 old buildings in Edmonton, mostly schools, which were similar to buildings frequently colonized in Medicine Hat and Lethbridge, produced no evidence of active maternity colonies.

A strong preference was evident for the formation of maternity colonies in older buildings; 56 of 60 buildings with Big Brown Bat maternity colonies were built prior to 1925. Banding studies (Beer 1955; Davis et al. 1968; Barbour and Davis 1969) have demonstrated strong site attachment of Big Brown Bats. Failure to colonize newer buildings may indicate a decreased or stable population that is strongly attached to roosts currently in use. Alternatively the variable environment in older buildings may meet the physiological needs of

the bats better, by permitting both summer and winter roosting. Many nurseries were evidently utilized as hibernacula by at least a few (and often many) bats in Alberta, as noted by others (Mills et al. 1975; Hitchcock 1949). Environmental conditions in newer buildings are likely to be different as a result of recent changes in heating systems and insulation standards.

Big Brown Bat roosts were similar to those described elsewhere (Barbour and Davis 1969; Mills et al. 1975); those we observed were generally cooler than Little Brown Bat (*Myotis lucifugus*) maternity roosts inspected. Big Brown Bats were extremely tolerant of light in some roosts.

Many owners of the buildings that were used as maternity roosts by Big Brown Bats believed that bats were resident during the winter, although only 19 reported having seen bats in this period. Other buildings, particularly in the city of Edmonton, that were not maternity roosts were utilized by wintering bats. Our winter captures of Big Brown Bats, and citizen submissions of bats for rabies testing from Edmonton, far exceeded those of summer. On the other hand, numerous summer submissions were made of Little Brown Bats and a few Silver-haired Bats (*Lasionycteris noctivagans*) (Dorward et al. 1977; this study, unpublished data). These observations suggest that Big Brown Bats moved into Edmonton to hibernate.

Five buildings in Edmonton and one non-maternity roost building in Camrose and Hinton regularly were occupied by bats in winter. As many as six bats captured in one winter at two of these sites were known to us; however, it is unlikely that most bats encountered in these buildings were reported. Winter occurrences were frequently associated with the onset of cold weather. In addition Big Brown Bats have been discovered during the course of building demolition and remodelling; and in one case, loud rock bands in a high school gymnasium were considered almost certain to cause bat activity.

As noted by Barbour and Davis (1969) *E. fuscus* is extremely cold-tolerant. Two individuals were captured outside a building on 3 December 1975. Temperature at time of capture was near −15°C, and had been even lower earlier in the day. One bat was alert and shivering; the other was torpid, but quickly became active when warmed. The bats had roosted near a recently filled crack and may have been attempting to enter the building.

Timing of events at maternity roosts was difficult to define as visits were made irregularly. It was evident, however, that there was variation between colonies, and probably between years. Bats were active at one location, which was thought to be a hibernaculum as well, on 8 April 1976 and 13 April 1977. The nature of bat activity at these times was unknown as the apparent food supply was extremely limited. One maternity site was determined to be without bats as late as 10 May 1977.

Roosting in four types of groups (pregnant females, females with naked young, furred young, and lactating females) was observed in one maternity roost. Similar separate roosting, although usually in only two or three types of groups, was noted in other colonies. This grouping created uncertainty as to the timing of parturition, as generally not all the bats in a roost were known to have been observed. These groupings were thought to be related to differing thermal requirements of individuals at different stages of reproduction and growth.

Time of parturition varied considerably both in, and between, colonies. Fetal examination and observation of neonates indicated that most young were born in the latter part of June. The earliest estimated birth date was 5 June. Near-term pregnant females were taken as late as 12 July.

Of 114 adult females taken from maternity roosts during late May and early June, 105 were pregnant. Of 115 bats examined in advanced pregnancy, 15 had twins, which corroborates Christian's (1956) finding that one is the usual litter size in western North America. Sixty-two of 84 single young had implanted in the right horn of the uterus. Kunz (1974) also noted a tendency towards implantation in the right horn. Fetal sex ratio was near 50:50 (Table 1).

During 1974 and 1975 significantly more adult females ($P < 0.05$) than adult males were submitted for rabies testing (Table 1). During these two years public concern about bat rabies was high; more than 400 bats were submitted per year. It appeared that many normal-acting bats were submitted as rabies suspects from maternity roosts. Most bats submitted in 1976 and

TABLE 1—Age-specific sex ratio in samples of *Eptesicus fuscus* from Alberta, 1972 to 1977

Sample	Adults		Juveniles		Fetuses	
	No.	% Male	No.	% Male	No.	% Male
Colony survey						
20 May–31 July	261	3.1	100	45.0	73	52.1
1 Aug–30 Sept	69	23.2	79	26.6		
Rabies suspect						
1974–1975	107	36.4	46	60.9		
1976–1977	58	55.2	45	71.1		

1977, when approximately 200 bats a year were submitted, were either grounded or found in other atypical situations. In those two years the numbers of adult males and females submitted were similar (Table 1).

Juvenile males tended to leave colonies earlier than juvenile females during late July and August. They occurred significantly less frequently ($P < 0.01$) than juvenile females in our samples from buildings during August and September (Table 1). This earlier departure may have subjected them to higher mortality, as they were submitted for rabies testing more frequently ($P < 0.05$) than juvenile females (Table 1).

Results of dental aging (Figure 2) indicated a life-expectancy similar to that found by Goehring (1972) from a 20-yr banding study in a Minnesota hibernaculum. Our samples varied in age structure, particularly in the proportion of 1-yr-old bats (Figure 2). One-year-olds constituted 39% of the rabies-suspect sample; the sample was comprised of bats from the greatest variety of situations and capture dates, and may be the most representative of the population age structure. It is, however, made up of bats that died from natural or human causes. One-year-old females from maternity colonies made up only 16% of the sample (Figure 2). That only 15 of 31 1-yr-old rabies-suspect and survey females were parous or had suckled young demonstrated that many 1-yr-old females are non-parous as noted by Christian (1956) and Barbour and Davis (1969). Non-parous 1-yr-old females may tend not to roost in maternity colonies and may be more likely to be submitted as rabies-suspect bats than older females.

Ages of bats from Connaught School (Figure 2) have been discussed by Schowalter et al. (1978). Younger animals appeared to be underrepresented in that sample compared to the other samples and what would be expected from banding results (Goehring 1972). Estimates of the total number of adults in the Connaught colony in June ranged from 500 to 1000, comparable to the largest colonies noted by Mills et al. (1975). Those authors determined that there was an unknown density-dependent mechanism functioning to regulate populations in large colonies. The relatively small number of individuals in some of the younger age-groups in the Connaught sample suggests low survival of young or that a large proportion of juvenile females disperse from the colony prior to their second year. The pregnancy rate of adult females from Connaught, 45 of 51, while less than that of females from other colonies ($P < 0.05$), is not low enough to suggest that the regulatory mechanism operates primarily through limiting reproduction.

Tooth wear has been considered as a means of aging bats (Twente 1955; Christian 1956; Stegeman 1956). Mills et al. (1975) found a highly significant relationship between tooth wear and ages of 208 Big Brown Bats banded as immatures. They observed wide variation in wear rates of individual bats. One of us (JRG) recorded tooth wear of bats in the Connaught School sample. Although analysis was limited by the subjective nature of the estimates of tooth wear and the possibility of errors in aging by annuli, there was general agreement between the two methods (Figure 3). Tooth wear would appear to be potentially useful as a method of determining relative population-age structures of Big Brown Bats in Alberta.

The possibility of a population decline and the factors governing the growth and size of colonies

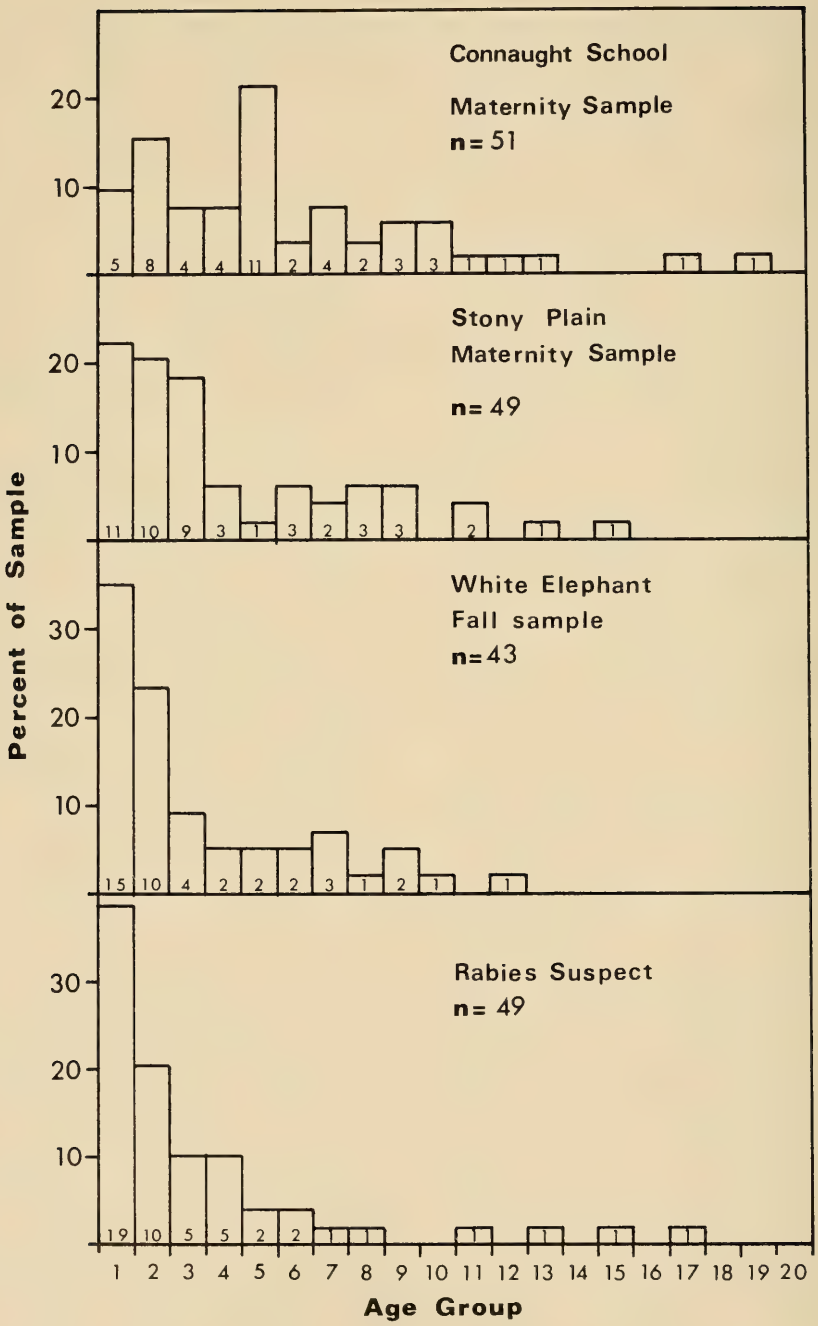

FIGURE 2. Distribution of ages of samples of Big Brown Bats from Alberta (determined by counts of dental annuli). Specimens from Connaught School, Medicine Hat; Stony Plain; and White Elephant Theatre, Bow Island. Numerals at base of bars indicate number of bats.

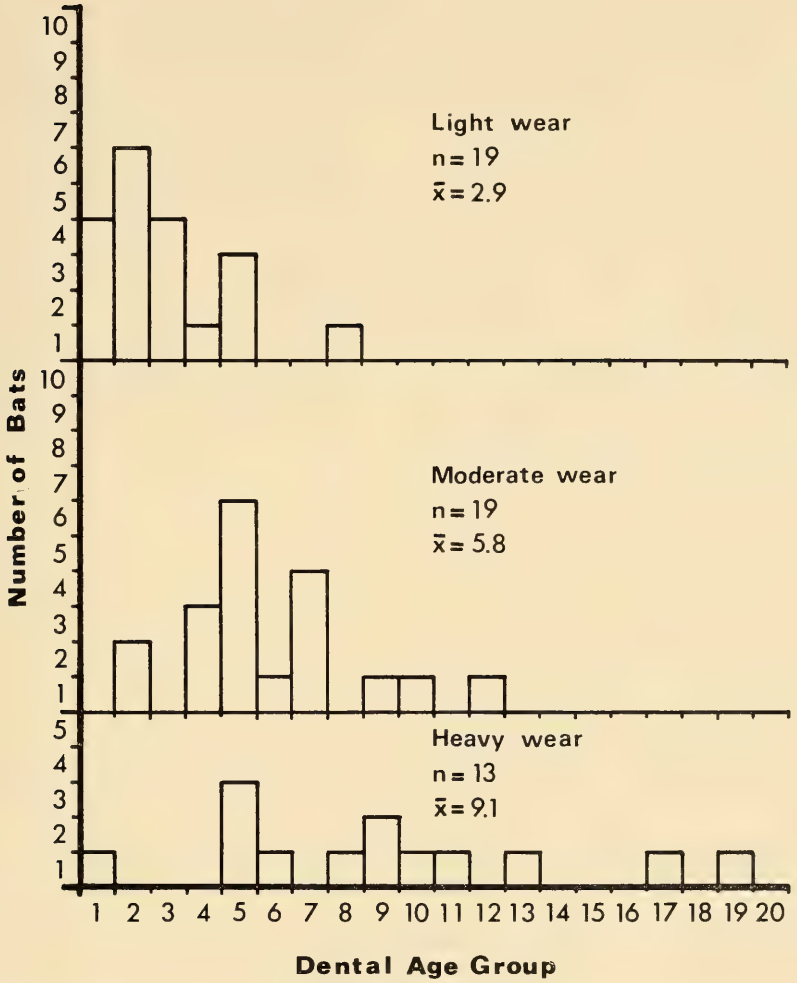
Light wear
n = 19
x̄ = 2.9
Moderate wear
n = 19
x̄ = 5.8
Heavy wear
n = 13
x̄ = 9.1
Number of Bats
Dental Age Group
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

FIGURE 3. Comparison of amount of tooth wear and ages, as determined by counts of dental annuli, of Big Brown Bats from Connaught School.

in central and southern Alberta need further investigation. Dental aging appears to offer a powerful tool in such investigations, although this technique requires further evaluation.

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Wild Mallard Stocking in a Large Marsh Habitat

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During 1971 and 1972, 1204 female and 214 male wild-strain Mallard *(Anas platyrhynchos)* ducklings were released on the Delta Marsh to test Mallard stocking as a method to increase breeding populations. Hand-reared yearling hens arrived after most of the unmarked hens in spring. Homing to the release site was observed in 26–28% of yearling hens and 53% of 2-yr-olds. Yearling marked hens initiated nests later and were less successful than unmarked hens in producing broods. Differences between the marked yearlings and unmarked breeders were attributed to the presence of the adult hens in the unmarked portion of the breeding population. In view of the poor reproductive success of hand-reared birds and apparently high potential for natural immigration and production, Mallard stocking is a questionable procedure on the Delta Marsh.

Key Words: Mallard, stocking, spring arrival, homing, nest initiation, productivity, breeding success.

Early propagation efforts involved mainly the release of semi-domestic strains of Mallard *(Anas platyrhynchos)* ducklings. Lincoln (1934), Errington and Albert (1936), Benson (1939), Foley (1954), Hunt et al. (1958), and Schladweiler and Tester (1972) concluded that releases of game farm birds were generally unsuccessful, because of the inability of these birds to survive and reproduce in the wild, and because they were extremely vulnerable to hunting. Stocking programs using wild-strain birds, however, have been successful in establishing Mallards (Foley et al. 1961; Lee and Kruse 1973) and Wood Ducks *(Aix sponsa)* (Doty and Kruse 1972) on vacant or understocked habitat.

In 1969 the Delta Waterfowl Research Station began to study the potential of releasing hand-reared wild Mallard ducklings to increase local breeding populations. Sellers (1973) made several releases into pothole habitat near Minnedosa, Manitoba, and the breeding population increased from 12 pairs in 1969 to 66 pairs in 1971 on his 2.56-km^2 study area. But only 9% of the homing (marked, hand-reared) females at Minnedosa produced broods in 1971. Sellers attributed poor production to severe nest predation associated with a lack of nesting cover. Upland nesting cover had been removed by agricultural tilling and burning. Based on those findings, the present study was initiated in 1971 on the Delta Marsh, where agricultural land use is negligible and nesting cover appeared adequate.

The objective of this study was to determine whether hand-reared Mallards would home to a specific release site in the Delta Marsh and, if so, would reproduce at a level to maintain their numbers. When it became evident in 1972 that yearling hens were not producing broods, the emphasis of the study was changed to a comparison of productivity in hand-reared and wild Mallards on the same areas.

Study Area

The Delta Marsh is a 140-km^2 expanse of shallow bays, creeks, and potholes at the south end of Lake Manitoba (Figure 1). The north edge of the marsh is separated from the lake by a sandy wooded ridge. Dense stands of Yellow Cane *(Phragmites australis)* interspersed with patches of White-top *(Scolochloa festucacea)* meadow cover most of the dry surface from the ridge to the bay edges. Cattail *(Typha latifolia)* grows in dense stands around potholes, creeks, and on flooded bay shorelines. Bulrush (*Scirpus* spp.) is common in large shallow bays. Additional description of topography, climate, and vegetation is given by Bird (1961, p. 19), Löve and Löve (1954), and Anderson and Jones (1976).

In 1971 duckling releases were made at the Diversion, 4.8 km W of the village of Delta. This study area is 2.56 km^2 in size, divided by the Assiniboine River Diversion. Creeks, potholes, and borrow pits are typical wetlands on the area.

In 1972 an additional release site was estab-

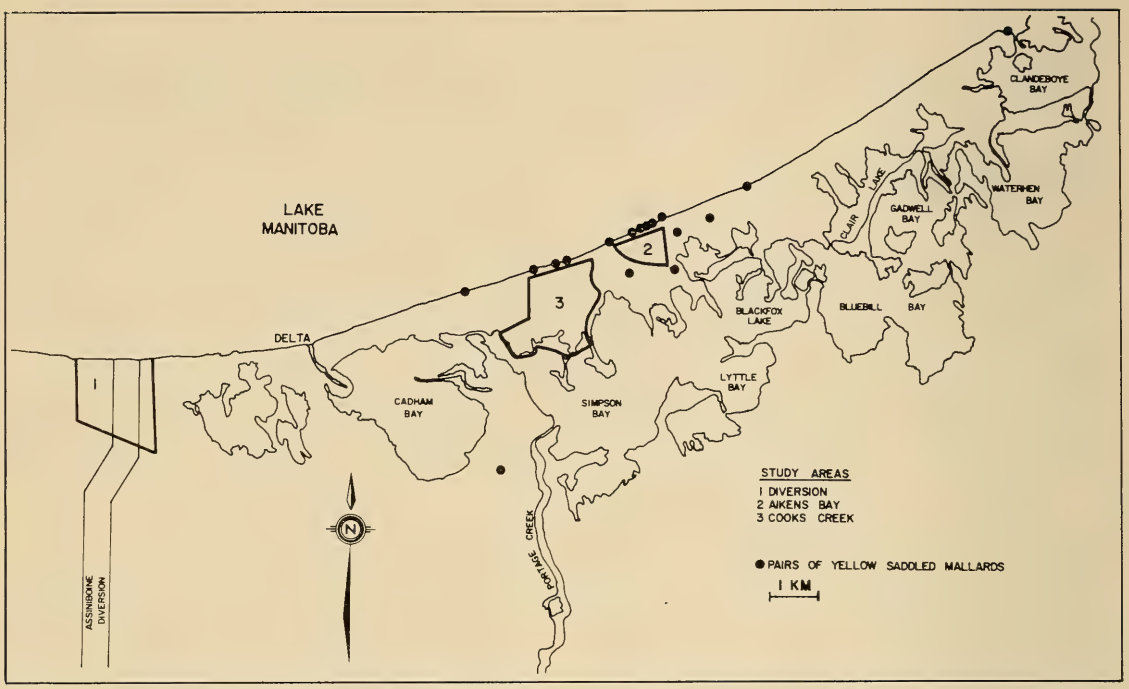

FIGURE 1. Map of the Delta Marsh illustrating the study areas and the location of marked females established outside the release sites in 1973.

lished at Aikens Bay, a 0.8-km^2 area, 8 km E of Delta. The aquatic and upland habitat at Aikens Bay was managed for waterfowl (mainly by water-level regulation) and was considered to be high quality. An unknown number of wild Mallards occupied each release site prior to stocking.

A 2.56-km^2 area at Cooks Creek Meadow, 4.8 km E of Delta, was chosen for a control (i.e., no birds released) in 1972. That area is typical marsh habitat.

In 1973 water levels were lower than usual on parts of the Delta Marsh. Wind tides from Lake Manitoba maintained water levels in the larger bays, but lack of precipitation left many nearby potholes and shallow marshes dry. Precipitation at Portage la Prairie was 7.62 cm lower than the long-term mean for 6 mo prior to 30 March 1973 (Atmospheric Environment Monthly Reports).

Methods

Ducklings were hatched in an incubator, from eggs taken from a captive flock originating from eggs gathered in the wild and hatched at Delta. Ducklings were hand-reared (Ward and Batt 1973) until 4–5 wk of age before release. Each duckling was fitted with an individually numbered plastic nasal saddle and a standard U.S. Fish and Wildlife Service leg band immediately prior to release. Birds were liberated in groups of 10–15 throughout all wetlands on the study areas.

In 1971, 456 females and 180 males were released at the Diversion. In 1972, 503 females and 34 males were liberated at Aikens Bay and 245 females at the Diversion site.

Mallard breeding densities were estimated by checking on foot each wetland on the study area. Each Mallard observed was checked for a nasal saddle. Counts were conducted as suggested by Dzubin (1969). A 12.87-km roadside transect was run 5–6 times a week on the Diversion and surrounding area each year and several walking transects were conducted at Aikens Bay. These transects provided information on the ratio of marked to unmarked females, homing hens, and the male:pair ratio. The ratio of marked to unmarked females was used to obtain an estimate of marked hens represented by drakes.

Sex ratio of Mallards counted prior to 15

April was applied to lone males and groups of five or less to correct breeding pair estimates for the unmated drake cohort. I assumed that all Mallards present were counted during each census.

Several square kilometres of marsh surrounding the study areas were searched each year for marked birds. Locations of marked hens were plotted on a map and revisited until the hen was identified or had disappeared.

In 1973, nest searches were carried out 2–3 times a week between 09:00 and 12:00 from the second week of April to the beginning of July. Two observers and a Labrador retriever participated in each search. Nests were located, plotted on a map, and marked with a piece of fluorescent tape on vegetation or a stake 3–4 m away. Nest initiation date was estimated for each nest by back-dating eggs in incomplete clutches (Dane 1966). Eggs in nests containing down were floated (Westerskov 1950) to estimate the approximate stage of incubation. Nests were revisited after the anticipated hatching date and nests containing finely crushed egg-shells and membranes were considered hatched.

Brood searches consisted of walking the emergents surrounding wetlands. The number and age of young (in weeks) and the marking, if any, on the female were used to avoid duplication in counts. This technique was supplemented with morning and evening road transects, walking transects, and observation periods wherein one block of habitat was observed for 2-3 h. Broods in Aikens Bay were observed from a 6-m tower in a central location on the site.

In spring 1973, 15 paired Mallard females were collected on the marsh, at least 2 km away from the study areas, in an attempt to estimate the proportion of adults in the unmarked population. Only females from isolated pairs were shot. Hens were qualitatively classed as yearling or adult based on examination of wing feathers (Carney and Geis 1960; Hopper and Funk 1970). Wings from known adults were examined for comparison.

Results

Spring Arrival and Breeding Densities

The first Mallards (six) in 1972 arrived on the Diversion on 7 April, and did not include any marked hens. On 13 April the first marked female and her mate were observed in a flock of five pairs on the study area. Most of the marked Mallards did not arrive until the week starting 21 April, when the mean number of marked hens observed per road transect increased to 3.85 from 0.58 the previous week. Over the same time period the mean number of unmarked hens observed per road transect decreased from 17.4 to 10.6.

TABLE 1—Mallard breeding pair counts (with 95% confidence intervals) on the Diversion and Aikens Bay, Delta, Manitoba. Pairs are corrected for sex ratio.

Study area	Pairs			Total
	1971 released	1972 released	unmarked	
Diversion				
5 May 1972	17 ± 7	—	19 ± 7	36
17 May 1972	19 ± 5	—	8 ± 5	27
Means	18.0		13.5	32
1 May 1973	6 ± 4	9 ± 4	11 ± 5	26
17 May 1973	9 ± 5	10 ± 6	12 ± 7	30
Means	7.5	9.5	11.5	28
Aikens Bay				
26 April 1973	—	14 ± 4	21 ± 5	35
8 May 1973	—	13 ± 4	9 ± 5	22
Means		13.5	15.0	29

Spring 1973 was phenologically very early, and the first Mallards arrived at Delta on 21 March. On 27 March a marked yearling hen was seen at Aikens Bay (Peter Ward, personal communication). When I arrived on 12 April, all hens were back.

The breeding pair censuses (Table 1) were timed to correspond with Mallard nest initiation dates as indicated by increases in the male:pair ratio along roadside transects. Prior to 15 April 1972, 496 Mallards were seen with a sex ratio of 57.3 males to 42.7 females. Prior to 15 April 1973, 543 Mallards showed a sex ratio of 54.7 males to 45.3 females.

Mallard breeding pairs on the Diversion averaged 32 per 2.56 km^2 in 1972 and 28 in 1973 (Table 1). Aikens Bay contained 29 pairs of Mallards (93 pairs per 2.56 km^2). Surveys commencing 14 and 21 May 1973, on Cooks Creek Meadow revealed a population of 54 and 55 pairs of Mallards per 2.56 km^2 respectively.

Homing of Mallards Released in 1971 and 1972

High pre-fledging mortality of an unknown number of ducklings in 1971 severely limited the number of hens alive to return in 1972 (Bailey, unpublished data). In all, 28 females were individually identified on the Diversion in 1972 (see below for number that actually settled on the area). All homing females were accompanied by unmarked drakes and no marked males were observed. Extensive searches of the surrounding marsh did not reveal additional marked birds.

Breeding pair counts indicated that about eight 1971-released birds returned to the Diversion in 1973 (Table 1). It was not possible to recognize individually all 2-yr-old females in 1973 because the paint had worn off many saddles. Assuming a 52% annual survival rate for adult females in southwestern Manitoba (Anderson 1975) and considering that 28 hens returned to the Diversion in 1972, then the eight birds observed in 1973 represented a homing rate of 53% for 2-yr-old females. This adult homing rate is considered minimal since the Delta Marsh is a major Mallard harvest area within southwestern Manitoba.

In 1973, 17 hens released in 1972 were identified on the Diversion (see below for number that settled). Marked hens from 1972 releases there appeared to have homed solely to the release site, because they were not found elsewhere in the marsh.

Females homing to Aikens Bay encountered high densities of marked and unmarked Mallards (Table 1). At Aikens Bay, 14 returning marked hens and 1 unmated marked male were identified. An additional 17 marked hens were observed scattered widely throughout the marsh E of Delta and W of Clandeboye Bay (Figure 1). Numerous marked females from Aikens Bay releases only established themselves on the lakeshore opposite Aikens Bay. Another marked male was observed with an unmarked hen at Marshy Point, 30.4 km E of Delta (Robert Blohm, personal communication).

I estimated that 186 of the females released at the Diversion and 366 females in Aikens Bay fledged in 1972. Robert Jones (personal communication) calculated that the first-year mortality rate of hand-reared Mallards released at Delta between 1954 and 1970 was 67.2%. To calculate homing rate I assumed this mortality rate for first-year fledged females in this study. The 17 returning hens at the Diversion in 1973 represented 28% of the possible yearling survivors. There was a 26% homing rate (n = 31) of marked yearling hens returning to Aikens Bay and the east marsh in 1973.

Comparison of Breeding Pair Counts and Homing Individuals

There was a discrepancy between the number of identified yearlings homing to the Diversion and the corresponding breeding pair estimates (28 identified homing in 1972 vs. pair estimate of 18; and in 1973, 17 identified homing vs. pair estimate of 9.5). This suggested that many homing marked hens were missed during the census or a certain proportion of marked yearlings visited the study area only briefly each year. In 1972, 13 (46%) of 28 homing hens were identified only once during 51 roadside transects on the Diversion whereas the remainder (15) were recognized an average of 4.7 times each. The mean residency bout for females sighted more than once was 32 d in 1972, as determined by the number of days between the first and last sighting. In 1973, 7 (41%) of 17 hens were seen only once during 53 transects and the remainder (10) recognized an average of 2.5 times. The mean residency bout was 31.3 d in 1973.

Nest Initiation and Productivity

Two of the earliest nests of unmarked hens were back-dated to 16 and 20 April 1973, whereas the earliest marked females (two) began nesting on 15 May. A second peak of nest initiation by unmarked hens occurred from 27 May to 2 June (Figure 2), and was apparently due to renesting and initial nesting by Mallards moving into newly-formed water areas after 3.2 cm of precipitation received during this period. A larger proportion of unmarked hens than of marked yearlings had started nesting prior to 15 May ($\chi^2 = 4.8$, $P < 0.05$, n = 36).

Generally poor reproductive success was recorded for released birds nesting as yearlings. Nest predators, chiefly Striped Skunks *(Mephitis mephitis),* Raccoons *(Procyon lotor),* and Red Foxes *(Vulpes vulpes),* were common on both study areas and accounted for most nest failures (Table 2). No marked Mallard hens with broods were discovered on the Diversion in

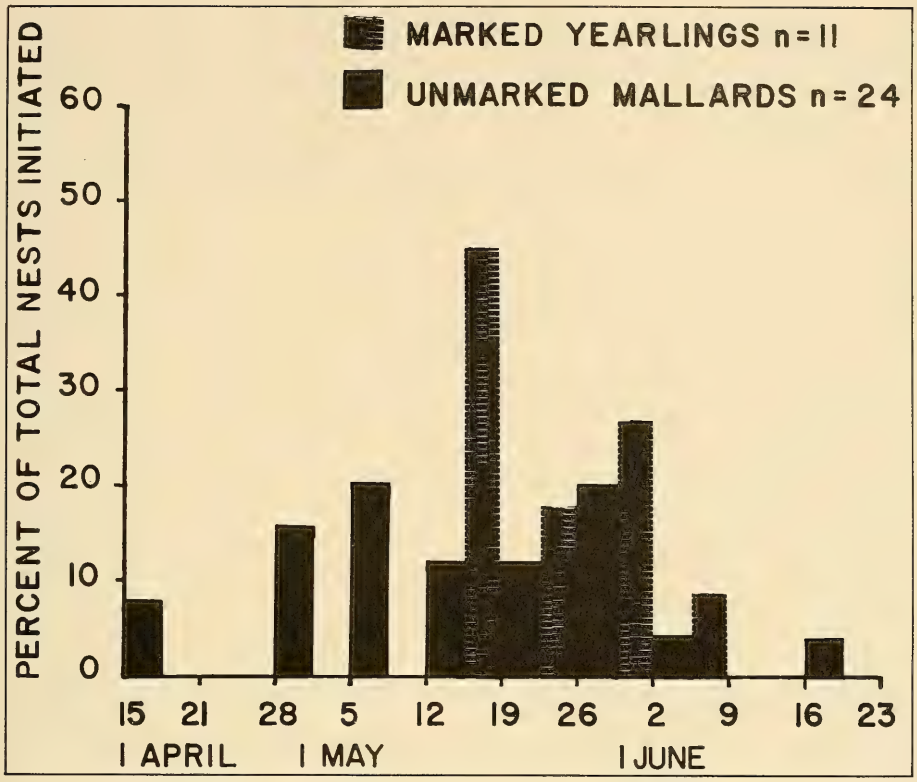

FIGURE 2. Distribution of nest initiation dates for marked yearlings and unmarked Mallards on the Delta Marsh study areas, 1973.

1972. In 1973, one brood of five ducklings was found with a 1972-released hen; however, no broods led by 1971-released hens were observed. Two marked hens with broods were found at Aikens Bay and two more marked hens with broods were located in the vicinity of the release site. One marked hen with a brood was observed on Cooks Creek, 1.6 km S of Aikens Bay.

Mallard breeding pair counts for the Diversion and Aikens Bay indicated that the ratio of marked yearling hens to unmarked females (41:40) was approximately 1 to 1 each year. Significantly more broods accompanied by unmarked hens ($P = 0.005$, binomial test, Siegel 1956), however, were discovered on the release sites.

TABLE 2—Nest success records for Mallards and other dabblers, Delta Marsh, 1973

Species	Year of release	Nests	Hatched		Destroyed	Not revisited[1]	Deserted
			No.	%			
Mallard							
marked	1972	11	2	20	8	1	0
marked	1971	3	0	0	3	—	0
unmarked		28	11	42	15	2	0
Other dabblers		81	23	36	32	19	7

[1]Not included in the calculation of the percentage of nests hatched.

TABLE 3—Percentage of marked and unmarked Mallard pairs producing broods at the Diversion and Aikens Bay in 1972 and 1973

Study area	Year of release	1972		1973	
		Number of breeding pairs	Percentage producing broods	Number of breeding pairs	Percentage producing broods
Diversion	1971	18.0	0.0	7.5	0.0
	1972	—	—	9.5	10.5
	unmarked	13.5	22.2	11.5	34.3
Aikens Bay	1972	—	—	13.5	14.8
	unmarked	—	—	15.0	50.0

Fourteen nests of marked Mallards were discovered during nest searches conducted in 1973 (Table 2). Eleven of these were nests of yearling hens, and three were initiated by 2-yr-old hens at the Diversion. Two of the 11 yearling nests hatched, 8 were destroyed by predators and 1 was not relocated. All three nests of 2-yr-old hens were destroyed.

Nesting success was 20% (n = 10) for nests initiated by marked yearling Mallards, whereas unmarked Mallard hens hatched 42% (n = 26) of nests initiated (no significant difference ($P = 0.150$) using a Fisher exact probability test (Siegel 1956)). The low probability obtained, however, suggests that the number of yearling nests found may not constitute a large enough sample to show a real difference, especially when a substantial proportion (see below) of the unmarked population was also yearling hens. When the combined nesting success of 1- and 2-yr-old marked hens was compared with nesting success of unmarked hens, the Fisher exact probability decreased to 0.070. Nesting success of other dabblers encountered during nest searches was 36% (n = 81).

Fifteen paired Mallard females were shot in spring 1973. These females included nine adults and six yearlings, based on wing-feather examination. Evidently there was a large proportion of adult females in the unmarked Mallard population.

The percentage of unmarked hens producing broods was much higher than that of marked hens on each study area in both years (Table 3). During the 2-yr study, 76 Mallard hens were identified as first-year breeders; of these, only 6 hens (8%) were observed with broods on or in the vicinity of the release sites.

Discussion

Most of the marked yearlings arrived well after the majority of unmarked hens. Spring arrival of hand-reared yearlings may extend over several weeks. Sellers (1973) concluded that yearling marked hens did not lag behind adults, based on the appearance of marked birds with the first arrivals in his area; however, he did not determine when the majority of marked yearlings arrived in relation to adults.

Wild-strain hand-reared Mallard females were able to return to specific release sites within the marsh. High pre-fledging mortality of 1971 releases did not prevent some survivors from returning to the study area in spring 1972. Homing of 53% (estimated) of surviving 2-yr-old hens to the Diversion showed that nesting failure during the previous year was probably not a deterrent to homing in subsequent years. A high percentage of adult hens homed in spite of low water levels in 1973.

Lower homing rates of yearlings compared to those of adults have been reported for Mallard, Gadwall (*A. strepera*), Pintail (*A. acuta*), Blue-winged Teal *(A. discors)* (Sowls 1955); Wood Duck (Bellrose et al. 1964); Shoveler *(A. clypeata),* (Poston 1974); and Tufted Duck *(A. fuligula)* (Mihelsons et al. 1970). The proportion of yearling marked Mallards homing was approximately one-half that of marked adults. Furthermore, only about 60% of homing yearling hens resided on the area for extended periods each nesting season. The remainder were sighted only once, usually prior to nest initiation or after nesting in July. These observations support the contention of Hochbaum (1955, p. 124) that some hens may home to their natal area but then move elsewhere to nest. On 29 July

1973, a flightless, 1972-released Mallard was observed 0.8 km S of Aikens Bay, so an unknown proportion of marked hens also used the marsh to molt.

Males did not generally home to release sites. In Mallards, pairing usually takes place on the wintering grounds and males follow their mates back to their natal area (Sowls 1955). But the appearance of one homing drake on Aikens Bay indicated that some drakes return to natal areas if unmated in the spring.

Numbers of Mallards seen in May and June aerial surveys of the marsh in 1973 increased 2.7 times over the previous three years' average (Delta Waterfowl Research Station, unpublished data). This increase may have also been partially due to low water levels causing birds to be more visible than usual from the air. The extremely high density of Mallard pairs at Aikens Bay in 1973 was partly due to the homing of release hens since one-half of the females found there were marked. The unstocked Cooks Creek Meadow also contained a relatively high density of Mallard pairs. It is possible that higher than usual numbers of Mallards on wet areas of the marsh in 1973 masked the effects of the stocking effort. In contrast, the Diversion held comparatively few Mallards after two years of stocking. The number of pairs on the Diversion remained the same each year, and there was evidence that marked yearlings were homing to, but not remaining on, the site. Marked yearlings also were found along the lakeshore at Aikens Bay. It is likely that the study areas were filled to capacity with breeding pairs.

Reproductive behavior and success of first-time breeders differs from those of adults in many birds (Lack 1966). Bellrose et al. (1964) found that yearling Wood Ducks nested later than adults. Grice and Rogers (1965) showed that yearling Wood Ducks were less successful than adults in obtaining nesting sites when breeding populations were high. Heusmann (1975) indicated that limited nestings, smaller clutch size, and lower brood survival led to poorer annual production by yearling Wood Ducks. Gates (1962) found that adult Gadwall females established home ranges and began nesting earlier than yearlings in the spring. Stotts and Davis (1960) showed that adult Black Ducks *(Anas rubripes)* were paired before yearlings and suggested that adults reach breeding "tempo" before hens nesting for the first time. Clutch size was also larger in adult Black Ducks. Mihelsons et al. (1970) found that yearling female Tufted Ducks started nesting later than the older birds and had comparatively poor success.

Yearling marked hens in this study arrived later on the release sites than most unmarked females, initiated nesting later, and were less successful than unmarked hens in producing broods. Lower productivity of released hens was apparently not caused by a lack of nesting cover, as found by Sellers (1973) because unmarked hens on the same areas were much more successful. Breeding by yearling hand-reared Mallards resembles a pattern observed in first-time breeders of other duck species, and lower productivity may be partly due to the fact that they are all breeding for the first time. The assumption that a considerable proportion of the unmarked Mallard population were adults was supported by the collecting of 15 hens.

Poor nesting success was also documented for a small sample of adult marked hens. Hence, the possible effects of hand-rearing on future breeding success remain unknown. It is important from a management standpoint to determine whether the differences observed between hand-reared and wild Mallards in this study are due to hand-rearing or age. The fact that no similar age-related breeding biology studies of wild Mallards are available to compare with these results points out an important research need. In view of the poor reproductive success of hand-reared birds and the apparently high potential for natural immigration and production, Mallard stocking is of questionable value on the Delta Marsh.

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Notes

Recent Collections of the Black Redhorse, *Moxostoma duquesnei*, from Ontario

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Kott, Edward, Robert E. Jenkins, and Gregory Humphreys. 1979. Recent collections of the Black Redhorse, *Moxostoma duquesnei* from Ontario. Canadian Field-Naturalist 93(1): 63–66.

The Black Redhorse, *Moxostoma duquesnei*, a species considered endangered in Canada, was recently collected from two localities on the Nith River, a tributary of the Grand River, Ontario. It has not been collected in Canada since 1938. This species is often confused with *M. erythrurum*, the Golden Redhorse. A comparison between these species is included.

Key Words: *Moxostoma duquesnei*, redhorse suckers, Ontario, morphology, endangered species.

The Black Redhorse, *Moxostoma duquesnei*, is generally found in clear streams of moderate width that are not subject to appreciable siltation. Because it is susceptible to siltation, it is becoming rare in many areas (Eddy and Underhill 1974; Cross and Collins 1975; Harlan and Speaker 1969).

This species has previously been recorded in Canada from only two localities in Ontario, both in the Lake Erie drainage: a tributary of the Grand River (Hubbs and Brown 1929) and from Catfish Creek (Hubbs and Brown 1929; Scott and Crossman 1973). The last recorded capture of this species in Canada was in 1938 and repeated attempts to collect it from Catfish Creek since then have failed (Scott and Crossman 1973). For this reason the species has been included in lists of rare and endangered Canadian fishes (Anonymous 1970; McAllister and Gruchy 1977). Some authors have even suggested that it may be extinct in Canada (Scott and Crossman 1973; McAllister and Gruchy 1977).

Specific locality records of previous collections of this species based on specimens in the University of Michigan, Museum of Zoology (UMMZ) and Royal Ontario Museum (ROM) are as follows:

UMMZ85887 Ontario, Catfish Creek, 1 mi W of Jaffa. 21 July 1927. Brown and Rupp. Total 45 spms., 1 ad (202 mm SL) others young (reported by Hubbs and Brown 1929), as 56 specimens.

UMMZ89075 Ontario, Oxford County (near Brant County line) Cedar Creek, tributary of Grand River between Paris and Princeton. 5 Sept. 1928. C. L. Hubbs. 3 specimens 75, 215, 215 mm SL (3 Aug. 1927 according to Hubbs and Brown 1929) [no stream in the area indicated currently bears the name Cedar Creek].

ROM1975 Ontario, Elgin County, Catfish Creek near Aylmer. 21 March 1926. H. C. White. 1 specimen, 253 SL.

ROM9637 Ontario, Elgin County, Catfish Creek. 26 March 1937. H. C. White. 1 adult.

ROM10364 Ontario, Elgin County, Catfish Creek south of Aylmer. 6 March 1938. H. C. White. 1 adult or subadult.

The Lake Champlain system of the St. Lawrence drainage was included in the range of this species by Hubbs (1930, p. 23) on the basis of "Greeley (MS)". Its range was indicated by Trautman (1957, map 44) to include much of the St. Lawrence drainage. Greeley did not publish such a record and no specimens are known from the St. Lawrence drainage. Its limited range in the Lake Ontario drainage (only the Genesee River system, western New York (Jenkins 1970, Figure 28) also indicates that the St. Lawrence drainage was not reached postglacially by the species.

Three specimens of this species were recently collected by two of us from two localities in the Nith River, a tributary of the Grand River, in the Lake Erie drainage basin, at least 35 km upstream from the other (year 1928) locality in the Grand River.

A single specimen, 49 mm standard length (Figure 1), was collected on 21 October 1976 just north of Plattsville, Oxford County, Ontario, (43°18′30″N; 80°37′30″W) using a 9-m, 6.4-mm-mesh seine. This part of the river consists of a stretch of swift-flowing shallow water (about 15 cm deep at the time) over a gravel bottom. This section ends in a pool about 1 m deep with a rubble bottom. The specimen, which was collected in the shallows, is in the Wilfrid Laurier University Museum as number WLU5594.

Two specimens (81 mm and 79 mm standard length) were collected using the same technique on 29 June 1977 (Figure 1) at the second locality just north of Ayr, Waterloo County, (43°17′45″N; 80°28′10″N) and 24 km downstream from the first. This segment of the river is similar to the previous in that it consists of

FIGURE 1. *Moxostoma duquesnei* collected from the Nith River: upper specimen, NMC 78–1; middle, WLU5233; lower, WLU5594.

a zone of rapids followed by a deep pool. The rapids had a boulder bottom with a depth up to 1 m. At low water levels, the pool was effectively divided by a gravel bar into two smaller pools. At the time of capture the depth of the pool was about 75 cm. The sides were gravel and the bottom was covered in fine silt. Both specimens were collected from the pool. One specimen is deposited in the Wilfrid Laurier University Museum as WLU5233, and the other at the National Museum of Natural Sciences, Ottawa as NMC78-1.

Moxostoma erythrurum, Golden Redhorse, was collected with *M. duquesnei* at the first locality and *M. macrolepidotum*, Shorthead Redhorse, was collected at the second locality.

The earlier and recently collected specimens of *M. duquesnei* agree in morphology and coloration with the species from elsewhere in the Lake Erie basin (tributaries in the United States) and from throughout most of the wide range of the species in the United States, from the southern parts of the lakes Ontario, Huron, and Michigan basins and southward.

The species in the Nith River system that most closely resembles *M. duquesnei* is *M. erythrurum*. Many workers encounter difficulty in distinguishing them. The following meristic data (taken by methods of Hubbs and Lagler 1958) are from specimens from the Lake Erie basin of Canada and the United States unless otherwise stated (Jenkins 1970 and subsequent study).

The best character for separation of these two species is the lateral-line scale count: *M. duquesnei* ranges 45–48, $\bar{x}$ = 46.4, N = 28; *M. erythrurum* 39–44, $\bar{x}$ = 41.0, N = 46. Slightly overlapping counts may be expected from additional specimens. Other meristic differences are the following: body circumferential scales (axis just anterior to dorsal fin), *M. duquesnei* 33–36, *M. erythrurum* 29–34; predorsal scale rows, *M. duquesnei* 16–20, *M. erythrurum* 13–16; pelvic fin rays, *M. duquesnei* usually one or both fins with 10 rays (in 19 of 28 specimens; nine with 9 as the highest count), *M. erythrurum* 9–9 or 9–8 in 50 of 52 specimens, 10–9 or 10–10 in the other two; post-Weberian vertebrae (counts from throughout total range of species), *M. duquesnei* 39–43 (40 in largest Nith specimen), *M. erythrurum* 35–39.

TABLE 1—Some characteristics of three specimens of *Moxostoma duquesnei* and 11 specimens of *M. erythrurum* from the Nith River

Specimen and museum number	Standard length, mm	Head length/ snout length	Eye diameter/ snout length	Caudal peduncle depth/ caudal peduncle length	Caudal peduncle depth/ standard length	Number of lateral line scales	Number of pelvic rays	
							left	right
M. duquesnei								
WLU5594	49	2.84	0.81	0.6	0.094	47	10	10
WLU5233	79	2.56	0.55	0.67	0.090	46	9	9
NMC78-1	81	2.55	0.61	0.7	0.095	46	9	9
Mean	69.7	2.65	0.66	0.66	0.093	46.3	9.3	9.3
Range	49–81	2.55–2.84	0.55–0.81	0.6–0.7	0.090–0.095	46–47	9–10	9–10
M. erythrurum								
WLU4763	41	3.3	0.94	0.68	0.102	40	9	9
	45	3.23	0.94	0.67	0.104	42	9	9
	47	3.29	0.94	0.68	0.094	42	9	9
	49	3.18	0.85	0.69	0.100	43	9	9
	49	3.3	0.89	0.68	0.090	43	9	9
WLU4556	54	2.62	0.69	0.72	0.106	44	9	9
	57	2.53	0.65	0.66	0.093	42	10	10
	59	2.90	0.76	0.71	0.102	43	9	9
	62	2.59	0.64	0.71	0.103	42	10	9
	62	2.62	0.68	0.68	0.094	41	9	9
WLU5305	75	3.02	0.87	0.91	0.111	40	9	9
Mean	54.6	2.92	0.80	0.71	0.100	41.8	9.2	9.1
Range	41–75	2.53–3.3	0.64–0.94	0.66–0.91	0.090–0.111	40–44	9–10	9–10

The species also differ in certain aspects of morphometry (Hubbs and Lagler 1958; Jenkins 1970; Phillips and Underhill 1971; Scott and Crossman 1973; Pflieger 1975) but greater overlap occurs with these characters than in at least most of the former. Some of the overlap is due to allometric growth of body parts and to comparison of samples of specimens with dissimilar body lengths (Jenkins 1970). Table 1 expresses the interspecific differences, with overlapping, based on the young and small juveniles from the Nith River.

A recently discovered difference, that is particularly useful for sorting large series of small specimens, concerns coloration of the upper body. The difference is best developed in the anterior dorsolateral area. In *M. duquesnei* the melanophores of each scale are more uniformly distributed, the total effect being an evenly dusky to darkly colored back. In *M. erythrurum* the posterior margin of each scale usually is obviously darker than the somewhat pale central area of the exposed portion of the scales, hence the scales appear somewhat bicolored. The difference is usually slight, but is discernible using syntopically collected and similar-sized specimens of the two species.

The size of the specimens collected, apparently young and small juveniles, indicates that a breeding population of this species still exists in Canada.

The Nith River follows a series of gravelly spillways until it unites with the Grand River (Chapman and Putnam 1966). For this reason it has a considerable gradient, with a minimum summer flow of about 2.8 $m^3 s^{-1}$. The region drained is rural in nature, with New Hamburg (population 2990 in 1974) being the largest center.

For part of its course it follows valleys 15.2–30.5 m in depth; the other stretches are bounded by floodplains. These floodplains are largely cleared and are used for growing grain or as pasture land; however, in some areas natural reforestation is occurring on abandoned or little-used farmland.

The river system is relatively clear, except during the spring flood period. Turbidity in Formazin Turbidity Units, for June and July, taken at a location near Ayr collection site was 2.70 and 2.40 (Anonymous, no date).

The Nith River system should be protected to enable the continued existence, in Canada, of the ecosystem that has harbored this species and other more typical elements of the biota of Canada. This species, itself, should be protected as an endangered species in Canada.

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Xanthochroism[1] in the Evening Grosbeak

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Helleiner, Christopher W. 1979. Xanthochroism in the Evening Grosbeak. Canadian Field-Naturalist 93(1): 66–67.

Key Words: xanthochroism, Evening Grosbeak (*Hesperiphona vespertina*).

This note describes two unusually pigmented Evening Grosbeaks, *Hesperiphona vespertina,* and summarizes several other reports between 1970 and 1977 in Nova Scotia. Xanthochroism in this species has previously been reported by Saunders (1958) and Godfrey (1967).

L.B. Macpherson (Maitland, Hants County, Nova Scotia) described an almost completely lemon-yellow and white male Evening Grosbeak in winter 1969–70. The primaries and tail were entirely white, except for the tip of one tail-feather, which was dark brown or black. The head was faintly tinged with olive, but the rest of the plumage was yellow. The legs and feet as well as the lower mandible were flesh-colored. The upper mandible was gray. The eyes were dark. The same bird, or one very like it, reappeared the following winter.

I saw a xanthochroic male Evening Grosbeak with somewhat more dark pigmentation in Halifax for a few days on and around 19 March 1977. The dark on the head, breast, and back were largely absent, except for a little coarse brown mottling on a yellow

[1]According to Harrison (Bird-Banding 1966, 37: 121) the use of the term "xanthochroic" should be limited to replacement of normal color by yellow. Most examples reported are more probably non-melanic schizochroic, where the absence of melanin leaves carotenoid pigments phenotypically apparent. I have therefore inserted the word "apparent" to modify xanthochroism in the text.

background. The dark color in the wings and tail appeared normal, but the white area seemed somewhat more extensive than usual, overlapping the dark primaries a little.

Both the Maitland and the Halifax bird behaved normally in the company of others of their species, and competed aggressively for food.

Less detailed reports of several other apparently xanthochroic Evening Grosbeaks have appeared in winter bird reports in the Nova Scotia Bird Society Newsletter in 1972, 1973, and 1977. These represent a total of about seven such individuals since the first specimen was collected in this province in 1958.

The Evening Grosbeak has become much commoner in Nova Scotia during the last two decades. Average numbers recorded on Christmas counts have increased from 330 to 1160 to 1610 per count in successive 5-yr periods starting in 1963 (Nova Scotia Bird Society Newsletter). One might therefore expect aberrant individuals to be seen more often. Nevertheless the frequency with which this otherwise very rare color variation is being reported in this species is surprising. Smith (1966) states that xanthochroism is rarer than other color variations in wild birds; Gross (1965) lists many examples of melanism, several of erythrism, but only six of xanthochroism. Perhaps in the Evening Grosbeak affected individuals do not suffer significant competitive disadvantage, and live to reproduce.

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Interaction between a Long-tailed Weasel and a Snowy Owl

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Boxall, Peter C. 1979. Interaction between a Long-tailed Weasel and a Snowy Owl. Canadian Field-Naturalist 93(1): 67–68.

A Long-tailed Weasel (*Mustela frenata*) was observed rushing towards a Snowy Owl (*Nyctea scandiaca*) and its recently-captured prey. This interaction is interpreted as attempted food piracy. The fearlessness of weasels may account for their presence in the diet of owls.

Key Words: *Mustela frenata, Nyctea scandiaca,* food piracy, predator.

Little is known about the relationships of weasels (*Mustela* spp.) to other predators. But the aggressive predatory behavior and curiosity of weasels have been described (Armitage 1961; Hansen 1952). While conducting research on the behavioral ecology of wintering Snowy Owls (*Nyctea scandiaca*), I witnessed an interaction between a weasel and a Snowy Owl.

At 11:24 on 15 December 1976, I was observing a large female Snowy Owl perched on a fence-post at the edge of a stubblefield, 6 km E of Calgary, Alberta. I noted a Long-tailed Weasel (*M. frenata*) moving slowly through the field approximately 30 m from the owl. At 11:25 the owl flew into the stubblefield, captured a small mammal, and remained on the ground with the prey item in its feet. During this time, the weasel was sitting upright about 20 m from the capture location, and had apparently witnessed the hunting attempt. After the capture, the weasel slowly moved to within 10 m of the owl. As the weasel approached, the owl picked up the prey in its bill, shook it several times, and started to swallow it. The weasel then ran quickly to within 3 m of the owl, whereupon the owl flew back to its original perch. The weasel continued forward and investigated the area where the hunting attempt occurred. Subsequently, the owl flew 500–600 m away and perched in a large tree.

Both owls and weasels are dependent upon rodents for food during the winter. Weasels, however, are

sometimes utilized as food by wintering Snowy Owls. Gross (1944) reports the remains of three weasels (species not given) in one Snowy Owl stomach. Catling (1973) found the stomach of one Snowy Owl in Ontario to contain an entire Ermine (*M. erminea*). In addition, I have found the remains of one Least Weasel (*M. nivalis*) and three Long-tailed Weasels in a sample of 100 pellets from the Calgary region.

Although the vision of weasels appears to be quite poor (Murie 1935), their ability to locate moving objects, and to detect prey by scent, is good (Ewer 1973). The weasel, during the interaction described above, behaved as if the owl's prey was detected by scent. I believe that the weasel's actions towards the owl were probably motivated by hunger.

The sudden rush by the weasel at the owl as the latter started swallowing the prey suggests a possible attempt at food piracy. The unusual behavior of the weasel, and the fact that the owl had just ingested a prey item, probably allowed the weasel to escape unscathed. Fearless behavior toward a larger predator, as described above, could explain in part the observed levels of predation upon weasels in nature.

I thank M. Ross Lein, Dick Braithwaite, and Tom Dickinson for criticism of the manuscript. This observation was made while I was conducting research supported in part by grants from the National Research Council of Canada to M. Ross Lein.

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Black-necked Stilts Nesting near Edmonton, Alberta

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Dekker, Dick, Robert Lister, Terry W. Thormin, D. V. Weseloh, and Linda M. Weseloh. 1979. Black-necked Stilts nesting near Edmonton, Alberta. Canadian Field-Naturalist 93(1): 68–69.

A series of sightings of Black-necked Stilts, *Himantopus mexicanus,* near Edmonton, Alberta, in the spring of 1977 culminated in the finding of two nests with eggs, which provide the first authenticated records of this species breeding in Canada.

Key Words: *Himantopus mexicanus,* breeding record, Black-necked Stilts, Alberta.

On 1 May 1977, when checking birds with Kathleen Ball and Bruce and Karen Heming at the southeast end of Beaverhill Lake some 80 km (50 mi) SE of Edmonton, RL was told by Ron Slagter of Edmonton that he had found two Black-necked Stilts on a shallow bay of the lake. They proceeded to the spot and saw the birds feeding with about 20 American Avocets, *Recurvirostra americana.* The stilts were viewed for about 20 min with binoculars and telescope at a distance of 50 m, but the birds were readily identified with the naked eye. Later it was learned that the birds had also been seen by Gerry and Betty Bulmer of Edmonton, who took recognizable photographs of them (Bulmer 1977).

On 3 May, RL was informed that R. C. Hodgins, of Stony Plain, Alberta, had seen another pair of stilts on a pond near St. Albert, about 10 mi (16 km) NW of Edmonton, but a later search of the area failed to relocate the birds. Hodgins is familiar with the stilt and was positive of his identification.

On 24 May, Dick Dekker reported two Black-necked Stilts on the north shore of Beaverhill Lake, and on 4 June, he found four of the birds in a marshy area on the west side of the lake. On the following day, Dekker and Lister went to view the birds. They were joined at the lake by the Weselohs and Thormin.

The area had been dry in April, but heavy rains and some snow later had flooded it, so in June it was mostly mud and water, in parts heavily overgrown with Marsh Ragwort *(Senecio congestus* var. *palustris).* At the marsh were three Black-necked Stilts and several avocets. One of the stilts seemed to run from a clump of ragwort, and resorted to a "broken-wing" distraction display. We withdrew for a time to give the bird a chance to return to a nest if it had one. After about 20 min we moved in, and again the bird was seen to run from a mound of mud. DVW waded through the mire and was rewarded by finding a nest and four eggs. He collected one egg which is now in the Provincial Museum of Alberta, and pictures were taken of the nest.

The nest was made of weed stems, apparently the stalks of ragwort, and was located just above the water level. Avocets' nests in the vicinity were all on dry land some distance from the water, which may have receded since the eggs were laid. All the avocet nests we saw had less nest material in them than that of the stilt.

On 17 June DVW and Eric Tull discovered a second stilt nest approximately 50 m west of the first one. The second nest contained seven eggs, one of which was also collected and preserved at the museum. This nest, except for the greater number of eggs, was similar in construction, content, and placement to the first. Three days later the first nest contained only one egg, which was pipped. By 07:45 on 21 June the chick had successfully emerged and was observed in the nest (DVW and Eric Mills). The fate of the young from the other two eggs is unknown, but they probably hatched on 19 or 20 June and were led to the nearby marsh. By 23 June the first nest was completely vacated and the second nest still contained six eggs. Hatching in the second nest was first noted at 06:10 on 4 July when the nest contained one young and five eggs. By 20:15 on 4 July, two young had emerged and a third could be heard peeping inside its cracked egg; the two young were banded by Martin McNicholl. On 7 July the second nest still contained three eggs which were cold and addled, and the remains of a unbanded young stilt were found only a few feet from the nest. Presumably this was the young that was heard peeping on 4 July. The three addled eggs were collected and are preserved at the museum.

The two nests of Black-necked Stilts near Edmonton, in 1977 contained 11 eggs, of which four definitely hatched, two probably hatched, two were collected early in incubation, and three were addled (and subsequently collected). Three young are known to have left the nest, two others may have, and one was found dead.

In the spring of 1977 there were far more avocets around Beaverhill Lake than RL could remember in about 50 years of visiting the lake (see also Dekker 1977). Dry weather in the western states as well as in sourthern Alberta, accompanied by very little run-off from the meagre snowfall of winter, had left many marshes dry, and it is possible birds had travelled far north of their normal breeding grounds to find suitable nesting habitat. There were also several sightings of Black-necked Stilts in Montana during the first week of May, and that state too recorded its first breeding records (two) of the stilt in 1977 (Paul Skaar, personal communication to DVW).

Salt and Salt (1977) list three previous sightings of the Black-necked Stilt in Alberta. Parts of a Black-necked Stilt are said to have been found (by Tom Randall) near Brooks in the mid-1950s but they were not preserved. On 12 May 1970, a bird was seen and photographed near Calgary (Weseloh 1972) and on 24 May 1972, another was seen and photographed near Irricana (Weseloh and McKay 1972).

Godfrey (1966) remarks "A set of eggs in the National Museum of Canada was, according to the label, taken at Qu'Appelle, Saskatchewan, on June 13, 1894, by Edward Arnold. This is so far from the known breeding range that the possibility of an error in the data seems probable." In light of the current Alberta and Montana nesting records, perhaps the Saskatchewan record should be given more credence.

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Addendum

No Black-necked Stilts were seen at Beaverhill Lake in 1978.

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Common Garter Snake Predation on Robin Nestlings

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Martin, Kathy. 1979. Common Garter Snake predation on Robin nestlings. Canadian Field-Naturalist 93(1): 70–71.

Key Words: American Robin, *Turdus migratorius,* nests, nestlings, Common Garter Snake, *Thamnophis sirtalis,* predation, prey selection.

During a two-year study of American Robins (*Turdus migratorius*) on Comox burn, a Douglas Fir (*Pseudotsuga menziesii*) plantation on Vancouver Island, British Columbia, a large percentage of nests were unsuccessful. Of 175 active nests found during 1971 and 1972, at least 59 (34%) were destroyed owing to predation (Martin 1973). The only predation I actually witnessed involved a Common Garter Snake (*Thamnophis sirtalis*) removing young Robins from a nest on the ground.

On 11 July 1971 at 16:15 I found a Robin nest well camouflaged under a fallen log. Three nestlings approximately 9 d old begged vigorously when approached, and I banded, weighed, and measured them. Their weights were 32, 35, and 54 g. On 12 July at 09:40 I found that a garter snake, approximately 90 cm long, had removed the smallest nestling and was ingesting it. Another young was out of the nest and the third remained in it. As I approached, the snake began to move away. It had ingested the nestling's head and neck, but the abdomen and legs were still dangling from its mouth. I wished to detain the snake for Martin McNicholl (MKM) to photograph, so I tied a string to the nestling's leg, attached it to a Red Huckleberry (*Vaccinium parvifolium*) stem and left the site. At 10:05 the snake had regurgitated the Robin and disappeared. I returned the live young to the nest, collected the dead one, and entered a small observation blind. At 11:30, I heard a nestling squawking and saw a snake pull the second lightest young (35 g) from the nest. The snake was biting or grasping the neck of the nestling as MKM and I approached. When the snake saw us, it tried to move away with the young Robin, but the nestling prevented this by grabbing vegetation with its feet. MKM took several photographs and we left the nest site. As I watched from a blind, the snake pulled its prey a short distance away and out of sight. At 12:00 the female Robin returned with food in her beak and remained near the nest chirping softly until 12:20 when she fed the remaining young (54 g) and flew away. The snake crawled out of a hole near the nest at 12:30 at which time it had ingested only the head and neck of the second nestling. At 12:50, the male Robin returned with food, but by then the snake had disappeared. At 13:45 I revisited the site and found the second nestling dead 6 m north of the nest. As there was no interference by humans or adult Robins after 11:30 it may be that the snake was unable to swallow this nestling. At 15:35, the third and largest young was still in the nest, and on 13 July at 11:10 found it fledged about 1 m north of the empty nest. At 12:00 on 13 July, the second dead young Robin was still near the nest and I saw a snake nearby of the same species and size as seen earlier. On 15 July at 15:45, the dead nestling was gone.

While I witnessed the predation, the adult Robins did not observe the snake, because they spent relatively long periods away from the nest and the snake was not present when they returned. The literature refers to snakes as occasional predators of Robin eggs and young (Bent 1949). On my study area, predation on Robin nests by garter snakes was probably infrequent because most Robin nests were situated approxmately 1 m above the ground in trees (Martin 1973). The major prey species of *T. sirtalis* on Vancouver Island are amphibians and earth worms (P. Gregory, personal communication); however, *T. sirtalis* does occasionally eat nestling birds, sometimes climbing small bushes and trees (Gregory 1975).

There have been a number of reports of snakes raiding passerine nests (Cink 1977; Best 1974, 1978; Ervin and Rose 1973). Both Cink (1977) and Best (1974) reported that snakes ate the complete clutch of eggs or young. Best (1974) reported Blue Racers (*Coluber constrictor*) returning to the nest after they had removed all the contents. I have found no reports that snakes have shown selectively in killing nestlings. My observations indicated that a snake first killed the lightest and smallest nestling. It then returned and killed the second-lightest nestling, possibly indicating prey selection by size. Because the snake abandoned the second nestling, perhaps these young Robins were larger than normal prey and too large to ingest.

I thank P. T. Gregory, M. Harris, M. K. McNicholl, and F. C. Zwickel for comments on the manuscript.

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Distribution and Movements of Selkirk Caribou, 1972–1974

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Freddy, David J. 1979. Distribution and movements of Selkirk Caribou, 1972–1974. Canadian Field-Naturalist 93(1): 71–74.

Distribution and movements of Caribou inhabiting the Selkirk Mountains of northeastern Washington, northern Idaho, and southern British Columbia were determined through aerial and ground surveys from 1972 to 1974. During most of the year, Caribou were located in British Columbia at elevations above 1430 m, in close association with the spruce-fir forest. Significant seasonal shifts in elevations frequented by these animals were not detected. Caribou consistently utilized specific travel routes between and within drainages. Their only travel route to the USA was through Kootenay Pass. Continued viability of the population probably depends on safeguarding their movement routes and spruce-fir forest winter ranges.

Key Words: Woodland Caribou, Selkirk Mountains, distribution, movements, ranges.

Woodland Caribou, *Rangifer tarandus caribou* (Banfield 1961, p. 70), inhabiting the Selkirk Mountains of northern Idaho, northeastern Washington, and southern British Columbia (BC), Canada, may constitute the only population of Caribou frequenting the contiguous United States (USA). Caribou populations formerly existing in Maine and Minnesota were extirpated during the early part of this century (Palmer 1938; Nelson 1947). Populations in northwestern Montana and other portions of northern Idaho have apparently been severely reduced in number or extirpated (Evans 1960).

Historical reviews pertaining to Selkirk Caribou were assembled by Evans (1960) and Layser (1974). These accounts, based primarily on interviews, summarize observations and records of these Caribou from 1800 to 1971. Upon interpretation, these reviews elucidate probable distribution and general movements of this herd (Freddy 1974). Estimates of the historic size of this population have been based on inadequate data. Flinn (1959) felt there were at least 100 Caribou in the late 1950s while Layser (1974) estimated that 15–20 animals existed in the early 1970s. Recent work indicates that 25–30 animals form the population (D. Freddy. 1974. Report to international Caribou steering committee. Unpublished report, B.C. Forest Service, Nelson. 9 pp.). Whether this population has recently declined or is currently increasing, decreasing, or stable in size is unknown.

In 1971 the University of Idaho Wilderness Research Center and several organizations initiated a cooperative study of Selkirk Caribou to document the distribution and movements of this population. The investigation was prompted by ongoing and potential human activities that appeared to be threatening the continued existence of these Caribou.

Study Area

The study was conducted in the Selkirk Mountains between Priest Lake, Idaho and Kootenay Lake, BC. (Figure 1). Elevations range from 700 m to 2100 m. Maritime air from the Pacific Ocean continually affects the area resulting in frequent cloudiness and precipitation. Lower elevations receive about 75 cm annually and higher elevations, over 250 cm of precipitation, with 70% of this moisture occurring as

snow between October and March (USDA 1972). Snow begins to accumulate at higher elevations during October and by December all elevations are snow covered. In late February or March the snowpack begins to settle and harden as warmer temperatures become more frequent. During April, snow at lower elevations begins to melt and at higher elevations becomes thoroughly settled with depths of 3 m common at elevations above 1500 m. By late June, snow at lower elevations has melted but at higher elevations snow will persist in sheltered areas until early July.

Western Red-Cedar (*Thuja plicata*) – Western Hemlock (*Tsuga heterophylla*) and Engelmann Spruce (*Picea engelmanii*) – Subalpine Fir (*Abies lasiocarpa*) forest types dominate the area. The spruce-fir forest predominates at elevations above 1500 m, spruce-fir and cedar-hemlock codominate at 1400–1500 m, while the cedar-hemlock forest dominates at elevations below 1400 m. A more complete description of these vegetative associations is provided by Daubenmire and Daubenmire (1968).

Primary land use has been and continues to be timber production. British Columbia Highway 3 bisects the area and logging roads penetrate nearly every drainage.

Methods

Distribution and movements of Caribou were determined from aerial and ground observations of Caribou or their tracks. Seventeen aerial surveys were conducted from March 1972 through April 1973 using a Cessna 182 while four surveys were conducted from March to July 1974 with a Bell 206 helicopter. Flights were conducted on days when visibility and contrast were good and a snowpack was present. To avoid duplicate observations of tracks, flights during winter were made after recent snowfalls and during spring after the snowpack had melted sufficiently to remove tracks seen from previous flights. Fixed-winged aircraft were flown at 135–140 km/h at altitudes 150–300 m above the ground, depending on terrain. Helicopter surveys were generally flown at lower altitudes and slower speeds. There was one observer per flight. Aerial surveys followed fixed flight paths to standardize data collection (Freddy 1974). These surveys concentrated on elevations above 1500 m because Caribou and/or tracks could usually be seen only on the snowpack within the relatively open-crowned spruce-fir forest above this elevation. Misidentification of tracks during aerial surveys was considered to be minimal. Moose (*Alces alces*) and Mountain Goat (*Oreamnos americanus*) were the only other large ungulates present and the restricted distributions of these two species minimized problems in identifying tracks. Ground surveys were conducted from February 1972 through August 1974. These surveys were used to supplement aerial surveys especially in areas below 1500 m elevation. Areas selected for search were judged probably to be utilized by Caribou. Searches were made afoot and by snowmobile.

Elevations where Caribou or tracks were located were determined to the nearest 30 m from topographic maps and/or the altimeter of survey aircraft. A one-way analysis of variance was used to test for differences in monthly elevations of Caribou locations. Specific travel routes were determined by tracking Caribou on foot or from aircraft.

Results and Discussion

From February 1972 through August 1974, 238 observations of Caribou or tracks were recorded. Observations occurred during all months except December and January of each year.

Caribou frequented areas within BC, Washington, and Idaho. Areas of concentrated Caribou activity occurred in BC with drainages immediately north of Kootenay Pass receiving heavy utilization year round. Areas in the USA most commonly frequented by Caribou were adjacent to Snowy Top and Continental mountains (Figure 1). Caribou were found in BC and the USA during both winter and summer but most of the population remained in BC year round.

This observed distribution of Caribou (Figure 1) resembled the historic distribution of the population (Freddy 1974). Current limits of distribution were similar to historic bounds and areas adjacent to Snowy Top and Continental mountains and Kootenay Pass continued as focal points of Caribou activity. Areas in the USA within the southern portion of the population's range, however, apparently were not used as intensely as in the past. This could have been a function of the years of the study, rather than an avoidance of areas in the USA. Skoog (1968, p. 437) and Kelsall (1968, p. 108) describe distributional shifts of Caribou which can result in temporary absence from areas.

Caribou were usually located year round at elevations above 1430 m with the mean elevation of Caribou locations being 1657 ± 227 (SD) m. There were no significant differences in monthly elevation means ($P \leq 0.05$) which ranged from 1591 ± 204 (SD) m in October to 1734 ± 235 (SD) m in September (Table 1). The absence of distinct shifts in seasonal elevations frequented by Selkirk Caribou differs from movements reported for Caribou in Wells Gray Provincial Park (WGPP) in central BC (Edwards and Ritcey 1959). Edwards and Ritcey (1959) concluded that the elevational distribution of WGPP Caribou shifted markedly in response to accumulating or receding snowpacks. During fall, Caribou in WGPP

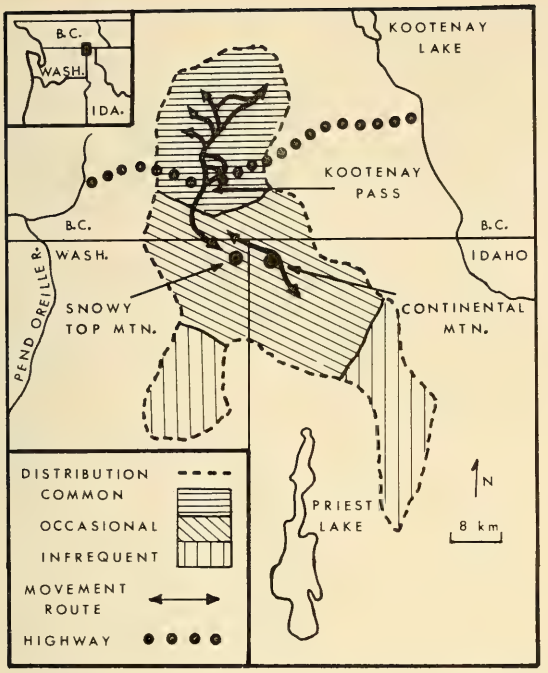

FIGURE 1. Distribution, frequency of occurrence, and known movement routes of Selkirk Caribou, 1972–1974.

moved down into the cedar-hemlock forest to avoid deepening snow at higher elevations and to forage on understory vegetation. As snow accumulated, Caribou ascended to the spruce-fir forest to forage on arboreal lichens, and then again descended to lower elevations in the spring. Although movements of Selkirk Caribou were apparently more variable, both populations frequented lower elevations in fall and associated with the spruce-fir forest in mid-winter. Food habits of Selkirk and WGPP Caribou (Freddy 1974; Edwards and Ritcey 1960) also suggest similar responses to changing snow conditions and availability of forage.

TABLE 1—Elevations at which Caribou or their tracks were observed, 1972–1974

Month[a]	Number of observations	Elevation (m), Mean ± SD	Range
February	22	1601 ± 234	976–1891
March	24	1712 ± 229	976–1952
April	19	1674 ± 169	1281–1952
May	56	1677 ± 185	946–1952
June	27	1665 ± 154	1342–1891
July	22	1693 ± 210	1312–2074
August	21	1638 ± 176	1281–2044
September	14	1734 ± 235	1281–2013
October	20	1591 ± 204	1281–1952
November	13	1645 ± 181	1342–1952
Totals	238	1657 ± 227	946–2074

[a]Surveys were not conducted in December or January.

Caribou consistently followed specific travel routes between and within drainages (Figure 1). Routes commonly incorporated natural passes along ridges, frequently followed stream bottoms, invariably proceeded through forested areas, and generally connected feeding and resting areas used by Caribou. Most routes were utilized during all seasons.

Critical to international movement of animals was the travel route through Kootenay Pass where Caribou had to cross a major highway (Figure 1). Kootenay Pass was the only known route used by Caribou to enter the USA, and historical accounts (Spry 1968, p. 480; Layser 1974) support the importance and long-term use of this route by Caribou.

Elevations frequented by Selkirk Caribou indicate that these animals utilize the cedar-hemlock forest and especially the spruce-fir forest year round. Forested areas above 1430 m must be considered vitally important to this population. The close association of Selkirk Caribou to the spruce-fir forest during winter reflects their use of arboreal lichens (*Alectoria* spp.) as a primary winter food (Freddy 1974). Edwards and Ritcey (1960) also found arboreal lichens to be a principal winter food for Caribou in WGPP. Edwards et al. (1960) indicated that mature stands of spruce-fir, as opposed to cedar-hemlock, produced the greater amount of arboreal-lichen biomass available for consumption by Caribou. The association of *Alectoria* spp. with mature stands of spruce-fir places this forage in conflict with extensive clearcut logging (Edwards et al. 1960; T. Ahti. 1962. Ecological investigations on lichens in Wells Gray Provincial Park, with special reference to their importance to mountain caribou. Unpublished report, Department of Botany, University of Helsinki, Finland. 63 pp.).

Consistent use by Caribou of specific travel routes implies that routes should remain undisturbed to allow established patterns of distribution and range use to continue. Klein (1971) reported that Reindeer (*R. t. tarandus*) have strong traditions for specific migratory routes and that realignment of such routes is difficult. Proposed expansion of BC Highway 3 to four lanes at Kootenay Pass could easily jeopardize future movements of Caribou into the USA. Klein (1971) reported highways and railroads have obstructed movements of wild reindeer in Norway.

The continued viability of the Selkirk Caribou population depends on cooperative international management. Although Caribou continue to frequent the northwestern USA, in all likelihood perpetuation of mature spruce-fir forests frequented by Caribou in BC is essential to the occurrence of these animals in

the USA. Timber harvest programs and other human developments in both BC and the USA must be coordinated to maintain known movement routes and spruce-fir winter ranges.

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Effects of Fire on the Location of a Sharp-tailed Grouse Arena

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Fire is known to be an important factor in creating and maintaining Sharp-tailed Grouse (*Pedioecetes phasianellus*) habitat (Amman 1957; Kirsch and Kruse 1972). Controlled burning has been used to improve Sharp-tailed Grouse habitat in several areas (Amman 1957, 1963; Baumgartner 1939; Grange 1948; Kirsch and Kruse 1972; Miller 1963). Few observations are available, however, on the immediate effects of fire on Sharp-tailed Grouse behavior. Amman (1957) suggests that fire does not affect arena use by males. Anderson (1969) reports male Greater Prairie Chicken (*Tympanuchus cupido*)

continuing to use an arena the day after it had been burned. During the spring of 1975 we observed the effects of a fire on a Sharp-tailed Grouse arena near Chatfield, Manitoba (50°47'N, 97°34'W).

Since 1970, spring surveys of arenas have been conducted in the Chatfield area. Known arenas were visited in early morning and numbers of male and female grouse recorded. The counts were conducted three or more times a week from early April until mid-June.

Arena A was used by males in 1971 but not in 1972 or 1973. Surveys were not conducted in 1974 owing to flooding of much of the area. During the spring of 1975, a new arena (B) was located 480 m north of the now abandoned arena A, in the same area of open grassland (Figure 1). Vegetation in the grasslands (Gr) consisted of native grasses, chiefly Needle Grass (*Stipa spartea*), June Grass (*Koeleria cristata*), and wheat grasses (*Agropyron* spp.) as well as a variety of forbs and scattered Saskatoon (*Amelanchier alnifolia*) and Snowberry (*Symphoricarpos occidentalis*) shrubs. The shrub area (Sh) contained clumps of Dwarf Birch (*Betula glandulosa*) and Saskatoon. The forested portion (Fo) was dominated by Trembling Aspen (*Populus tremuloides*).

When arena B was discovered on 7 May, 10 birds of unknown sex were present. Counts on subsequent mornings showed between 7 and 10 males displayed at this arena prior to 23 May. During this period birds were never observed displaying at arena A. On 23 and 24 May, a fire burned the southwestern portion of the grassland area and eliminated all residual grass and forbs but did not greatly affect shrub or tree cover in the area burned. Arena A was completely burned over whereas arena B was unaffected (Figure 1).

On 25 May two non-displaying Sharp-tailed Grouse were present on arena A and eight males were displaying on arena B. Between 26 May and 1 June, one or two birds were displaying on arena A, and four to seven on arena B each morning. By 16 June only one bird remained on arena B while arena A had five to eight males actively displaying. Other neighboring arenas showed a decrease in the number of males during June, as is typical in late spring (Hamerstrom 1939). On 17 June no birds were on arena B but five birds were still attending arena A. After this date birds were not present on either arena.

The difference in vegetative cover between arenas A and B prior to the fire was not obvious. After the fire arena B was still covered by rank residual grass and forbs in addition to the current season's growth. Arena A had only new growth which was sparse until several weeks after the fire.

Several authors have shown that most Sharp-tailed Grouse arenas are in areas of sparse ground cover (Amman 1957; Kobridger 1965; Sisson 1975). According to Amman (1957), males may abandon sites with tall or dense ground cover. The shift we observed at Chatfield may be explained by birds moving back to the traditional arena (A) after its vegetation cover was reduced by fire to a more acceptable height. The lack of tall cover would permit displaying males to see and be seen, which are two requirements of arena sites (Anderson 1969). In 1976 and 1977, displaying males used arena A regularly but were never seen where arena B had been in 1975.

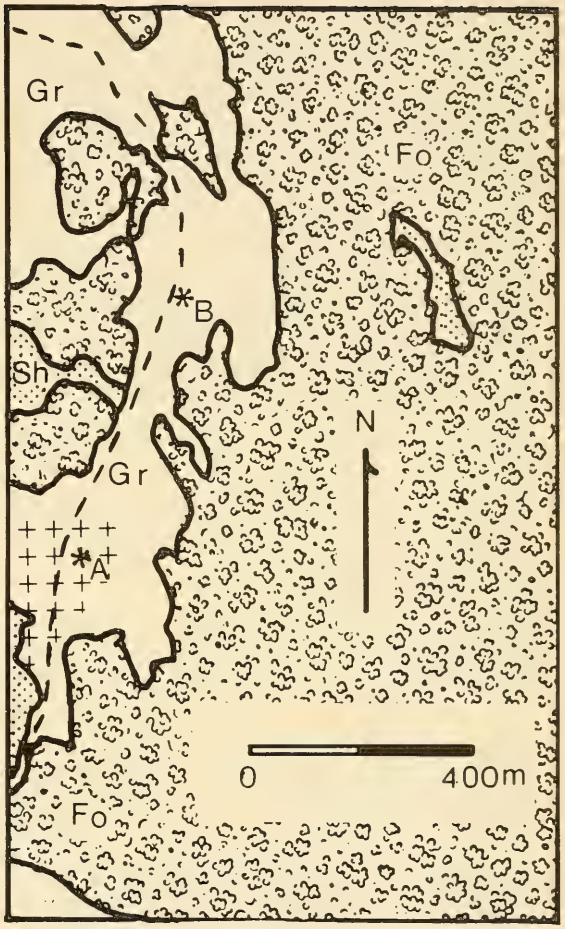

FIGURE 1. Location of arenas and extent of burned area (++) on Chatfield study area. Note grassland (Gr), shrub (Sh), and forest (Fo).

These observations were made during a study of population, movements, and habitat use of Sharp-tailed Grouse conducted by the Manitoba Department of Renewable Resources and Transportation Services. We thank G. W. Pepper, S. G. Sealy, and M. W. Shoesmith for comments on the manuscript.

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Brewer's Blackbird Breeding in the Northwest Territories

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Stepney, Philip H. R. 1979. Brewer's Blackbird breeding in the Northwest Territories. Canadian Field-Naturalist 93(1): 76–77.

The occurrence of Brewer's Blackbird breeding in the Northwest Territories was verified at Fort Simpson, 27 June 1977. Additional courting individuals were observed at Hay River on two occasions in the same year. This breeding record represents an appreciable northward expansion of the range of this species and is seemingly related to increased modification of previously forested areas.

Key Words: Brewer's Blackbird, breeding, range extension, Northwest Territories.

Brewer's Blackbird (*Euphagus cyanocephalus*) has increased both its breeding range (Stepney and Power 1973) and winter range (Stepney 1975) in this century. Typically distributed in western North America, (A.O.U. 1957), habitat modification resulting from agricultural and transportation route development has seemingly aided the expansion of this species (Roberts 1932).

Previously, the Meikle River formed the northern limit of the breeding range of Brewer's Blackbird in the Peace River region of Alberta (Godfrey 1966). In adjacent northeastern British Columbia, a "family" group had been recorded in 1967 at Fort Nelson, where the birds were observed again in 1974 (Erskine and Davidson 1976). Previous authors had not recorded this species in the Fort Nelson region. There are apparently three earlier records of non-breeding Brewer's Blackbirds occurring in the territories: Fort Simpson, District of Mackenzie, on 15 June 1958, Baker Lake, District of Keewatin, in November 1923 (Godfrey 1966), and north of Old Crow, Yukon Territory, (three birds) in 1971 (Schweinsburg 1974).

In 1977 the author observed Brewer's Blackbirds in two locations in the District of Mackenzie. At Hay River, on 28 May, two pairs of mated birds were observed along the railroad right-of-way adjacent to the airfield. The males were observed courting and guarding the females and engaging in pursuit flights, behavior typical of breeding Brewer's Blackbirds (Williams 1952). Time did not permit a search for nests. On 8 September 1977 Brewer's Blackbirds were again recorded in Hay River. Four mature males were observed within the town, suggesting that a small colony was present in Hay River that summer. At Fort Simpson, on 27 June, a single pair of adults with five fledglings were observed in the cleared area adjacent to the gravel airstrip within the town. The young were flying among the willow shrubs paralleling the airstrip; the adults mobbed me while I searched unsuccessfully for the nest-site, which probably was located on the grass-covered bank of the airstrip drainage ditch.

The occurrence of Brewer's Blackbirds at Fort Simpson is approximately 360 km northeast of their

previous northern limit in British Columbia. This breeding expansion is appreciable but not unexpected in view of the highway and rail-line developments in this originally forested area. It seems likely that the modified habitats along these rights-of-way provided dispersal routes for Brewer's Blackbird. This species has been observed penetrating forested areas along cleared rights-of-way in areas of Alberta (Smith 1975), Saskatchewan and British Columbia (A. J. Erskine, personal communication).

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A Trap to Measure *Populus* and *Salix* Seedfall

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John C. Zasada and Roseann Densmore. 1979. A trap to measure *Populus* and *Salix* seedfall. Canadian Field-Naturalist 93(1): 77–79.

A seed trap, a wooden frame (1 × 1 m × 5 cm) with a plastic sheeting on the bottom to hold moistened potting soil was used in Alaska to determine seedfall for *Populus* spp. (poplars) and *Salix* spp. (willows) through germination of seedlings. This seed trap takes advantage of these species' ability to germinate rapidly under ambient temperatures and optimum moisture conditions.

Key Words: Seed dispersal, natural regeneration, seed trap, Salicaceae, Alaska.

The types of seed traps used to measure seedfall vary greatly. Forest tree seedfall is usually measured with rectangular or circular traps which vary in surface area and height of collecting surface above ground (Sarvas 1962; Zasada and Gregory 1972). Werner (1975) described a trap that contained a sticky surface to which seeds adhered. Ryvarden (1971) used a water-filled trap to study seed dispersal in alpine areas of Norway.

Although these traps could be used for studying *Populus* (poplar) and *Salix* (willow) seedfall in Alaska, two factors make them less than perfect. First, within any part of Alaska, there may be more than one species from each genus contributing to the seedfall. Although these species disperse seed at different times, there can be significant overlap. Thus it is desirable to identify the contribution of each species. Seeds of the two genera can be separated on the basis of color (i.e., *Populus* seed is tan to white in color, *Salix* seed is green). Further, it is possible after some experience to separate *P. tremuloides* (Trembling Aspen) from *P. balsamifera* (Balsam Poplar). Willow seeds, however, cannot be separated easily on the basis of features identifiable in the field. Second, because of the small size of these seeds it is laborious and time-consuming to separate seeds from other debris that lands in seed traps and then to germinate them.

We designed, and have been using for 2 yr, a seed trap that takes advantage of the rapid germination of

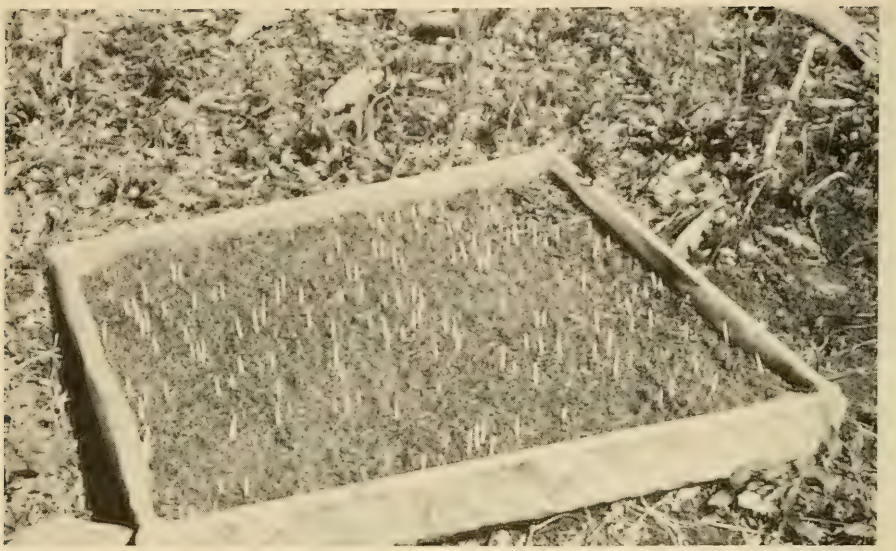

FIGURE 1. Seed trap with aspen seedlings in early July. Toothpicks mark seedling locations.

Populus and summer-dispersing *Salix* under optimum conditions of temperature and moisture (Zasada and Viereck 1975). Seeds of these two genera must germinate shortly after landing on the seedbed or they die (Schreiner 1974; Brinkman 1974).

Our trap is a 1- × 1-m wooden frame (5 cm deep) covered on the underside with one layer of 4-mil plastic sheeting (Figure 1). The trap is filled with a standard potting soil, such as Jiffy-Mix,[1] that is kept wet. If flooding from heavy rains is a problem, holes should be cut in the frame just below soil level. So that soil stays wet, holes should not be punched in the sheeting.

It is important that the commercial potting mixes not have an inhibitory effect on germination of these species. We have not observed any effect from Jiffy-Mix[1] or Jiffy-Mix Plus[1] in growth chamber studies.

Traps should be placed in the field prior to seed dispersal. Germinants are counted periodically and left to develop until they can be identified. Seed collected from identified willows and poplars and germinated on trap soils can be used as an aid to identify unknown germinants.

We have used the traps on upland and floodplain sites in interior Alaska. On a birch (4.9 ha) and aspen (2.8 ha) clearcut we used four traps in each area to measure seedfall. Aspen seedfall was estimated to be 383 seeds/m^2 in the aspen clearcut and 376 seeds/m^2 in the birch clearcuts (coefficients of variation 25% and 19%, respectively). The first seed dispersal was observed on 10 June, the first germinants between 12 and 16 June, and the last germinants on 14 July (Table 1). Only aspen seedlings were observed in these traps. Figure 1 shows traps in early July.

Four traps placed on a floodplain produced seedlings of a number of species (Table 2). The traps were set out after dispersal of *Salix alaxensis*. They were within an 8-yr-old stand (traps 1 and 2) or on an open sandbar adjacent to it (traps 3 and 4). The main species in this stand were *S. interior, S. alaxensis,* and *P. balsamifera*; less common species were *S. novae-anglicae* and *S. monticola*. Seedlings of species that are rare or absent on these sites (e.g., *S. bebbiana*, *P. tremuloides*) were produced as well as those of species occurring in the stand.

TABLE 1—Number of aspen germinants and percent of total number germinating on a given date in four seed traps located in clearcuts on upland sites in 1977

	Aspen	Birch
Number of germinants		
Mean ± SD	383 ± 99	376 ± 72
(range)	(277–516)	(353–436)
Percent germinating		
16 June	55.3	46.8
23 June	26.2	36.7
3 July	7.8	7.7
7 July	9.6	7.5
14 July	1.1	1.3

[1]The use of trade, firm, or corporation names does not constitute endorsement by the U.S. Department of Agriculture.

TABLE 2—Species composition and number of germinants observed in four seedtraps located on floodplain sites adjacent to the Tanana River, Alaska

Species	Traps within 8-yr-old stand		Traps on open sandbar	
	1	2	3	4
Salix lasiandra[1]	12	5	1	2
S. bebbiana	33	50	5	12
S. arbusculoides	3	2	—	—
S. monticola	5	0	—	—
S. interior	45	281	7	26
S. novae-anglicae	6	2	1	1
S. planifolia	1	2	1	1
Populus balsamifera	4	2	5	5
P. tremuloides	41	49	48	3
Unknown *Salix* sp.	14	4	9	3

[1]Terminology follows Argus (1973).

Our observations demonstrate that the seed trap is feasible, but several drawbacks exist. First, depending on the weather conditions, the traps may have to be watered as frequently as every day. Second, the variable measured with these traps is the number of germinants, which is not necessarily the total number of potentially viable seeds reaching the trap. We believe that by keeping the traps saturated, the number of germinants is a good estimate of the number of viable seeds; but this point needs further examination.

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Examination of Overwintering Adult Carabid Beetles for Associated Mites

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Olynyk, J. E. and R. Freitag. 1979. Examination of overwintering carabid beetles for associated mites. Canadian Field-Naturalist 93(1): 79–81.

Mites are commonly associated with adult carabids in northwestern Ontario from spring to fall but are not normally found on the beetles during winter. This suggests that the mites are phoretic on the carabids, using them for transport during times of the year when the carabids are active.

Key Words: northwestern Ontario, mites, beetles, Carabidae, Acari, ectoparasites.

In North America, collections of carabids during winter have been rare and no previous work has been done on mite populations associated with hibernating carabids. Aitchison (1976), using pitfall traps, studied numerous invertebrate groups in subnivean environments in southern Manitoba. She collected very few carabids in December and March and none in January or February. Olynyk and Freitag (1977) did not capture any carabids in pitfall traps near Thunder Bay, Ontario, between 9 November and 6 April, though Olynyk (1978) found an average of approximately eight mites per captured carabid between May and October. Larochelle (1972a, b, 1973, 1974) made several collections of hibernating adult carabids in southern Quebec but did not record the presence of mites on the beetles (personal communication).

The purpose of this study was to determine winter associations of ground beetles and mites in the context of annual relationships.

Materials and Methods

Carabids were collected between 6 and 26 April 1977 in 200 pitfall traps near Thunder Bay, Ontario (Olynyk and Freitag 1977). Three hand collections were made in the same location in 1977 on 19 November and 3 and 23 December. Mounds of earth, rotten stumps and logs, and surrounding areas on, in, and under the leaf litter were inspected. Larochelle (1974, 1975) noted that such locations were some of the most productive sites for collecting carabids in winter. On 22 April 1978, hand collections were made beside Ontario Highway 588 near the junction of Highways 11/17 and 588 in northwestern Ontario. Areas under loose materials including logs, metal, tires, boards, and cardboard were inspected.

All carabids collected were placed in individual vials of 70% ethanol. External surfaces and areas under elytra were examined on each beetle collected under a Wild M5 dissecting microscope. Alcohol from vials containing carabids was filtered through Kimwipe tissue and the tissue then examined for mites.

Carabids were identified to species using identification keys by Lindroth (1961–1969).

Results and Discussion

Table 1 contains a list of the carabids collected. On the 53 carabids collected, representing five genera and six species, we found no mites on external surfaces or under elytra.

Carabids collected in November and December were found beneath rotten stumps and were torpid. Approximately 80% of the carabids collected on 22 April were found beneath a sheet of metal, the rest beneath a nearby sheet of cardboard. Burrows were present, the carabids were congregated and many were torpid. The ground was frozen.

TABLE 1—Carabids collected in early spring and winter of 1977 and 1978 in pitfall traps and by hand near Thunder Bay, Ontario

Date	Carabid species	Sex ♂	Sex ♀
26 April 1977	*Pterostichus adstrictus*	1	3
	P. pensylvanicus	4	7
19 November 1977	*Sphaeroderus nitidicollis*	1	2
	Calosoma frigidum		1
	P. pensylvanicus		2
	Agonum decentis		1
3 December 1977	*S. nitidicollis*		1
23 December 1977	*S. nitidicollis*	1	
22 April 1978	*P. pensylvanicus*	1	3
	Calathus ingratus	11	14

Greene (1975) found acarid hypopi appearing on carabids in August in Washington, with many hundreds commonly present on the carabids by October. No data were recorded for hibernating carabids, but few if any mites were present on carabids in spring, which suggests that the mites did not overwinter on the carabids. W. M. Graham of Lakehead University studied ants and associated mites populations near Thunder Bay in 1969 and 1970 (March 1978, personal communication). Average mite numbers per ant were lowest in spring and fall, suggesting that the mites did not overwinter on the hibernating ants. Olynyk (1978) noted that the numbers and frequency of occurrence of mites on carabids were lower in spring and fall. As none of the 53 hibernating adult carabids examined carried mites, it can be assumed that the mites do not overwinter on the carabids.

Aitchison (1976) found that carabids in southern Manitoba were inactive at temperatures below about –2°C. She collected large numbers of mites in midwinter and concluded that their activity seemed to be unrestricted by temperatures encountered in her study.

Mites phoretic on carabids, using them solely as a transport mechanism, would gain no such benefit from hibernating carabids. It follows that mites phoretic on carabids in other regions likewise are not found on hibernating carabids.

Acknowledgments

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Ring Counts in *Salix arctica* from Northern Ellesmere Island

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In 1962 I collected two large specimens of *Salix arctica* Pall., which had been eroded out of steep-sided postglacial benches roughly 100 m above the present level of Lake Hazen, Northwest Territories, at about 81°50′N, 71°15′W. They were to have been picked up by R. E. Beschel, but, when he failed to do so, they lay forgotten in a drawer for years.

I have now cut sections from the main stem and a major branch of each specimen. The sections were polished, cleared with lacquer, and ring counts were made under the dissecting microscope. The short cool growing season in the high Arctic makes some rings very narrow or incomplete; and some such rings may not be definitely distinguishable even under the microscope.

The larger plant (*Savile 4841A*) yielded counts of 84, 84, and 85 (at least partial) rings on a radius of about 36 mm from the markedly eccentric origin. These are minimum counts, because some of the early rings are thought to have included some with almost zero growth. The outermost rings are relatively wide, indicating vigorous growth in the final years of the life of the plant, A large branch yielded 36 rings without any wide outer ones. Possibly death of this branch diverted nutrients into the main stem. R. E. Beschel and D. Webb (1964. Axel Heiberg Island Preliminary Report. *Edited by* F. Müller. McGill University, Montreal. pp. 189–198. Processed) indicate that *S. arctica* periodically loses branches.

The second specimen (*Savile 4841B*), with maximum wood radius of 28 mm, yielded a minimum of 43, 44, 44, and doubtfully 48 rings in separate sections, and again most of the last few rings were relatively wide. Sections from both specimens have been deposited in DAO.

I suspect that both plants were killed by erosion of the bench on which they grew, because vigorous growth in their last years does not suggest the senescence inferred by Warren Wilson (1964) for plants of this species at Resolute (74°41′N), where little or no growth seemed to occur after about 50 yr. Although the Hazen Camp specimens are from about 81°50′N, they are better grown than any at Resolute, largely because Hazen Valley, being ringed by mountains, is subject to dynamically warmed winds and has relatively high summer temperatures; but partly, perhaps, because sites such as the raised branches have good drainage and a deep active layer. The difference is reflected in the flora: about 115 species of vascular plants in Hazen Valley and 70 at

Resolute. For comparison of these and some other arctic sites see Savile (1972, p. 11). It should be noted that on some sites, notably depressions flooded by Lake Hazen in midsummer, *Salix arctica* makes very poor growth.

It seems probable that, barring soil movement or other accidents, plants on favorable sites in Hazen Valley have either an indefinite life or a much higher life limit than at Resolute. It is worth noting that, of the 12 plants counted from Axel Heiberg Island (all about 79°25′ to 79°30′N) by Beschel and Webb, one showed 87 and all the others between 18 and 64 rings. My specimen, *4841A*, is perhaps the oldest recorded north of 80°N. A few large and vigorous plants up to about 3-m spread were seen near Hazen Camp, but I did not feel justified in sacrificing any of them for the sake of a ring count.

I am grateful to a reviewer of this manuscript for drawing my attention to the mention by Raup (1965) of specimens of *Salix arctica* at about 73°N in Northeast Greenland of up to 210 and 236 yr old.

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Giant Cow Parsnip (*Heracleum mantegazzianum*) on Vancouver Island, British Columbia

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Dawe, Neil K. and Eric R. White. 1979. Giant Cow Parsnip (*Heracleum mantegazzianum*) on Vancouver Island, British Columbia. Canadian Field-Naturalist 93(1): 82–83.

The known distribution of the Giant Cow Parsnip (*Heracleum mantegazzianum*) on Vancouver Island, British Columbia is reported. A discussion of the time span the plant has taken to become established is included along with notes on the dispersal of the plant from one site of introduction.

Key Words: distribution, *Heracleum mantegazzianum,* Vancouver Island, weeds.

The distribution of the Giant Cow Parsnip (*Heracleum mantegazzianum*) in Canada was recently described by Morton (1978) as occurring primarily in southern Ontario. He also cites a record from Vancouver on the west coast (Kamermans 1977); however, there is no mention of the plant's occurrence on Vancouver Island. Taylor and MacBryde (1977) list but one species of *Heracleum* for British Columbia: *H. sphondylium* (= *H. lanatum*). This note documents the occurrence of *H. mantegazzianum* on Vancouver Island and will alert naturalists to the possible occurrence of the species in other areas of the province.

During summer field work of 1978 we discovered a large number of *H. mantegazzianum* plants growing along the banks of French Creek, near the creek mouth, approximately 6 km NW of Parksville, British Columbia (49°21′N, 124°22′W). Subsequently two other groups of plants of that species were brought to our attention. Jennifer McGown (personal communication) told us of the first group. That group consisted of a small cluster of plants in a vacant Fifth Street lot at Nanaimo, British Columbia, approximately 35 km SE of the French Creek site. The cluster was growing alongside a dry ditch edge amongst a large patch of *Rubus discolor*. All the plants were taller than 3 m, and all had gone to seed. The second group was discovered near a vacant lot at Victoria, British Columbia in circumstances similar to those of the Nanaimo specimens (Harold Hosford, personal communication). Specimens from these sites were verified (T. C. Brayshaw, personal communication)

and are now on file at the British Columbia Provincial Museum, Victoria. After the lodging of our *H. mantegazzianum* species with the Provincial Museum, Brayshaw informed us that another specimen was located in the museum herbarium. That specimen, collected in 1973 from the French Creek site, was incorrectly labelled *H. lanatum*.

At the French Creek location the plants were found in large clusters on both sides of the creek. One collected specimen measured 395 cm from the base to the top of the terminal umbel, with a terminal umbel width of 70 cm. The stem was 9 cm thick at the base. The lower 26 cm of the stem was a deep purple while the rest of the stem was green covered with purple spots and blotches decreasing in extent toward the umbel. Clear hairs protruded from most of the spots. The fruit was elliptic and ranged from 12.0 to 13.2 mm in length. The vittae were swollen near the base and at that point averaged slightly over 1 mm in width.

Further investigation revealed large numbers of *H. mantegazzianum* upstream in suitable locations and subsequently they were found growing along a tributary of French Creek where it crosses Swayne Road, approximately 2 km S of Coombs, British Columbia. The plants grew along the banks of the creek, south to a point just past the intersection of the tributary and Winchester Road. Here the local distribution of the plant abruptly ended. French Creek and another of its tributaries crosses Winchester Road a further 1500 m and 600 m north, respectively; however, an inspection of both sites did not reveal any specimens of *H. mantegazzianum*. Because of that, we feel the area of introduction of the plant lies in the general location of the southernmost tributary of French Creek near its crossing of Winchester Road.

We talked with local residents, and in particular to Frances Kroot (personal communication) who lives near the presumed site of introduction, to try to determine the time span *H. mantegazzianum* has taken to establish itself. Apparently the plant was not known to occur in the area in 1937; however, by 1944 it appeared sporadically where the forest edged away from the creek, and beside bridges where openings were created. Here the plant's history becomes nebulous, but by 1967, when Frances Kroot came to the area, the plant was well established. By 1975, and likely years before, it was known to be well established near the mouth of French Creek, some 12 km downstream. As Morton (1978) reports that the principle mode of dispersal is by water, this further supports our conclusions regarding the site of introduction.

All the residents we talked with mentioned the stinging effect and the blisters which occur upon coming in contact with *H. mantegazzianum*, as described by Morton (1978), and all requested information on methods of eradicating the plant. Bert Topliffe (personal communication) described his attempts to rid them from his yard. He made repeated applications of the herbicide 2,4,5-T and this seemed to be effective shortly after application. The following year, however, they reappeared as numerous as before. He has since found that only by continually mowing the plants does he have any success. Topliffe also mentioned observing a number of people each fall collecting the large umbels. He recalled one occasion when a couple loaded the back of their pick-up truck with the dried stalks and umbels. This, undoubtedly, could disperse the plant over large distances and may account for the Nanaimo specimens.

The discovery of *H. mantegazzianum* on Vancouver Island appears to warrant the concern expressed by Morton (1978). Hazards of coming into direct contact with the plant have already been mentioned. Perhaps more important, however, is its ability to become well established within a relatively short time, likely at the expense of some of our native species. On Vancouver Island *H. mantegazzianum* established itself within 30 yr along suitable areas of French Creek and one of its tributaries, moving a distance of approximately 12 km within a period of less than 40 yr. It is well established along virtually the entire waterway from the site of introduction to the French Creek mouth. In some locations the plant grows 80 to 100 m away from the creek edge. The plant's potential for spreading even further is increased through the dispersal of its seeds by humans in their quest of dried umbels, presumably for home decorations. Coupled with those factors are the difficulties encountered in trying to eradicate the plant once it is established.

As Morton (1978) points out, we need more information as to the distribution, life history aspects, and control methods of *H. mantegazzianum* in Canada. Naturalists should also be alert to the possibility that the plant occurs within their area and has to date been passed off as an aberrant form of a locally common species.

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Nesting of Horned Puffins in British Columbia

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Campbell, R. Wayne, Harry R. Carter, and Spencer G. Sealy. 1979. Nesting of Horned Puffins in British Columbia. Canadian Field-Naturalist 93(1): 84–86.

Summer observations of Horned Puffins (*Fratercula corniculata*) from 1972 through 1977 suggest that this species is expanding its range along the British Columbia coast. Nesting was confirmed at one new site and probably occurred at three others.

Key Words: Horned Puffins, *Fratercula corniculata,* British Columbia, breeding range.

The status of the Horned Puffin (*Fratercula corniculata*) on the west coast of North America south of its breeding range in southeastern Alaska (A.O.U. 1957) was reviewed recently by Sealy and Nelson (1973) and Hoffman et al. (1975). These authors considered it a late spring and early summer (and occasional winter) visitor to this area but did not report evidence of breeding. Forrester Island, Alaska, was heretofore the southernmost known breeding site in the eastern Pacific (Heath 1915; Willett 1915).

Censuses of, and other work in, seabird colonies along the British Columbia coast from 1972 through 1977 indicate (Table 1) that the Horned Puffin is now more widely distributed along the west coast of the Queen Charlotte Islands and Vancouver Island than previously known. It also has been recorded on the central mainland coast.

Possible Nesting Sites

Marble Island (52° 12′N, 132° 39′W). This is a fairly large, wooded island, about 150 m high, with dense undergrowth above the precipitous cliffs. On 19 July 1977 two Horned Puffins scrambled from a natural rock crevice on a large grassy slope among a colony (hundreds) of Tufted Puffins (*Lunda cirrhata*). Later, five Horned Puffins were seen at one time circling off the island with Tufted Puffins. During the half hour the Horned Puffins were watched, an adult several times flew to, and almost landed near, its presumed nest site. The following day two Horned Puffins were again seen flying with Tufted Puffins off the island.

Unnamed Islet (52°06′N, 131°14′W). This islet, off the northwest coast of Anthony Island, is about 30 m high, is composed of bare rock with deep cracks and fissures, and has grassy areas along its north tip. Six Horned Puffins were seen flying with Tufted Puffins close to the islet on 2 July 1977. Two days later, a Horned Puffin flew from a crevice near the top of a steep rocky bluff; later we discovered a recently cracked egg in the crevice. Later the same day we watched up to five Horned Puffins, for an hour or so, fly very close to the islet, but none landed or entered a natural crevice. All other possible nest sites were inaccessible without climbing equipment. On 5 August, four Horned Puffins were flushed from rocky vantage points above where they had been seen in early July.

Cape St. James (51°56′N, 131°01′W). This landform consists of the St. James Islands, which are saddle-shaped, bare, and grassy with vertical cliffs about 30 m and the Kerouard Islands, which are mostly grassy, unforested, and up to 76 m high. Horned Puffins were recorded near Cape St. James during the summers of 1972 through 1974 and also in 1977. H D. Fisher (letter to SGS, 26 September 1974) was not aware "that the occurrence of Horned Puffins at the Cape (May to August) and carrying fish at that, would be valuable news. The common puffin in the Kerouards is the Tufted Puffin. But among these we always saw a few Horned Puffins. Whenever we were enroute to and from the sea-lion rookeries, they [Horned Puffins] seem to nest on the cliff directly below the weather station on the northernmost Kerouard, a very inaccessible place."

Triangle Island (50°52′N, 129°05′W). This, the most western of the Scott Islands, about 210 m high, is very precipitous with no trees. Horned Puffins were first recorded here in 1972 by C. J. Guiguet and have been observed nearly every summer since by biologists visiting or conducting research (Table 1; Vermeer et al. 1976). Although positive evidence is lacking, up to four pairs may breed on Triangle Island, all at the western end and near "Murre" rock.

Discussion

The observations presented here and those of Sealy and Nelson (1973) suggest that the Horned Puffin is more common in British Columbia than previously known. If this trend continues, opportunity will exist

TABLE 1—Summer observations of Horned Puffins in British Columbia, 1972-1977

Locality[1]	Date	Number[2]	Remarks
Queen Charlotte Islands			
Cox Island (Langara I.)	31 July 1977	1	Flying with Tufted Puffins
Darwin Sound	May 1977	4	In a flock flying south
Marble Island	19 July 1977	5	Suspected nesting
Marble Island	20 July 1977	2+	Flying with Tufted Puffins
Island NW Anthony I.	2 July 1977	6	Suspected nesting
Island NW Anthony I.	4 July 1977	5	Suspected nesting
Island NW Anthony I.	5 August 1977	4	Suspected nesting
Island E Anthony I.	4 July 1977	1	Flying alone
Cape St. James	May–August 1972	1 or 2	With Tufted Puffins
Cape St. James	May–August 1973	1 or 2	With Tufted Puffins
Cape St. James	May–August 1974	1 or 2	With Tufted Puffins
Cape St. James	5 July 1975	7	With Tufted Puffins
Cape St. James	27 July 1975	2	With Tufted Puffins
Cape St. James	3 July 1977	1	With Tufted Puffins
Cape St. James	4 July 1977	2	With Tufted Puffins
Mainland Coast			
Sinnett Island	27 June 1976	1	Alone off island on water
Joseph Island	28 June 1976	1	Flying alone
Vancouver Island			
Triangle Island	1 July 1972	2	Flying with Tufted Puffins
Triangle Island	16 June 1974	1+	On water near island
Triangle Island	2 July 1974	2+	On water near island
Triangle Island	21 August 1974	1	On nesting cliffs
Triangle Island	June–August 1975	1–6+	One carrying fish
Triangle Island	27 July 1977	1	On rocks on island
Triangle Island	28 July 1977	3	On water off island
Triangle Island	1 August 1977	8	On rocks
Solander Island	27 June 1975	3	Flying with Tufted Puffins
Barrier Islands	26 June 1975	1	On water off island
Wichaninnish Bay	20 June 1975	1	On water

[1]Listed from north to south.

[2]All observations of birds in apparent definitive plumage.

to monitor it. Therefore, it is important to interpret carefully our observations so that its status in British Columbia up to 1977 is clear.

The finding of a Horned Puffin nest containing an egg, on an unnamed islet northwest of Anthony Island in 1977, provides positive proof of breeding. The observations (Table 1) of birds carrying fish in their bills is evidence short only of finding an egg or chick. Where the above evidence is lacking, observations must be viewed with caution. Myrberget (1959) found that the varying proportion of non-breeding Common Puffins (*F. arctica*) present in a colony may equal the number of breeding birds there, and after 4 yr of age many individuals prospect for and even "own" burrows but seldom breed (Petersen 1976a). Many more 5-yr-old birds breed but maximum reproductive output does not occur until the birds are 10–11 yr old. In Alaska, many occupied Horned Puffin burrows during the breeding season never reach the egg stage, possibly because their "owners" are immatures (D. H. S. Wehle, personal communication). Such immatures in the Common Puffin are recognizable only on the basis of bill shape and the number and depth of bill furrows (Petersen 1976b). The presence of a Horned Puffin on a boulder or even in a burrow therefore does not imply nesting. Also, as noted by Lockley (1953), and confirmed by Petersen (1976a), Common Puffins that circle the periphery of a colony are generally immature. The breeders that are feeding young generally fly straight out to sea on leaving the burrows and straight back (carrying fish) when returning. In fact, Brun (1971) considered only those puffins carrying fish in their bills to be breeders when he censused colonies in northern Norway. Hence the presence of Horned Puffins of unknown age at best provides suggestive evidence for breeding. The finding of additional nests and additional observations of birds carrying fish will be required to confirm that this species is continuing to change its status in British Columbia.

Another puffin, the Rhinoceros Auklet (*Cerorhinca monocerata*), is actively expanding its breeding range (see Scott et al. 1974) and is recolonizing islands from which it had been exterminated (see Ainley and Lewis 1974).

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News and Comment

Special Appreciation Expressed to R. Emerson Whiting

We are particularly grateful to R. Emerson Whiting for his careful and thorough preparation of the Index for *The Canadian Field-Naturalist* from 1975 to 1978 (Volumes 89, 90, 91, and 92). His particular concern for accuracy and his attention to details is not only appreciated by the journal but more so by the users of the Index. We sincerely thank Mr. Whiting for his time and effort because the Index is such an important component of each volume. We are pleased to announce that W. Harvey Beck has agreed to take on the task of indexing Volume 93.

LORRAINE C. SMITH
Editor

Second International Congress of Systematic and Evolutionary Biology

The Second International Congress of Systematic and Evolutionary Biology (ICSEB-II) will be held at the University of British Columbia, Vancouver, Canada on 17–24 July 1980. The provisional list of symposia topics include these:

1. Arctic refugia and the evolution of arctic biota.
2. Origins and evolution of the north Pacific marine biota.
3. Evolution of reproductive strategies.
4. Evolutionary epigenetics.
5. Evolution of community structure.
6. Green algae and land plant origins.
7. Macromolecular mechanisms in evolution.
8. Allozymes and evolution.
9. Coevolution and foraging strategy.
10. Evolution of colonizing species.
11. Rare species and the maintenance of gene pools.
12. Paleobiology of the Pacific rim.

Sessions for contributed papers and for papers in specialized fields, taxonomic as well as methodological, will also be organized.

Those interested in receiving an information circular in the spring of 1979, should write to *Dr. G.G.F. Scudder, Department of Zoology, the University of British Columbia, 2075 Wesbrook Mall, Vancouver, British Columbia V6T 1W5.*

Books Available from IUCN

(International Union for Conservation of Nature and Natural Resources)

Red Data Book — Birds

The first part of the completely revised edition of the *Red Data Book Volume II Aves* is now available from IUCN. A second part of similar size will be published next year.

This new edition has been prepared by Warren King on behalf of the International Council for Bird Preservation (ICBP) and the Survival Service Commission of IUCN. King has drawn on the expertise of hundreds of ornithologists throughout the world, including ICBP's National Sections and Working Groups.

The volume covers 199 bird taxa and includes birds that are threatened throughout their range. It does not deal with taxa that may be a threatened category within the boundaries of one nation but are relatively abundant elsewhere. Price (includes binder and dividers) is $30 (US).

World Directory of Protected Areas

The second instalment of the World Directory of National Parks and Other Protected Areas has been published. Covering a further 43 countries it brings the total number represented in the Directory (the first instalment was published in 1975) to 60. This second instalment also contains additional sheets for five countries previously covered: Australia, Canada, Congo, Iran, UK.

Now greatly enlarged the Directory is divided into two volumes: countries A–K, 317 pages; countries L–Z, 330 pages. The 397 new sheets of the second instalment plus the cover for Volume Two may be obtained direct from IUCN, price $60 (US) post free. For the complete two-volume set comprising covers, alphabetical dividers and 647 sheets, the price is $85 (US).

Societies and Amateur Ornithologists

The following are taken from the recommendations of the National (USA) plan for Ornithology submitted to the National Science Foundation and the Council of the American Ornithologists' Union (AOU).

10. Professional societies (preferably the AOU or an intersociety consortium) should form a committee charged with (a) developing projects of national ornithological importance for amateurs, (b) developing centers of responsibility for particular projects, and (c) providing professional assistance in securing and maintaining financial support for the projects.

11. The ornithological societies should undertake the development of a network of involvement by local bird clubs and nature centers. The initial step should be the preparation of a computerized listing of all clubs and contacts. The ultimate goal should be a Federation of American Bird Clubs or an ATO (American Trust for Ornithology) modelled on the British counterpart.

12. The AOU should take the initiative in improving formal coordination in the activities of the ornithological societies and in the work of the profession in general. An obvious option for this, perhaps only as a developmental stage, would be the formation of an intersociety coordinating council whose role would be to consider or initiate long-range policy of national or general professional scope, as well as to assist in the integration of routine activities.

13. The ornithological societies should take greater interest in the work of ornithological centers such as organized bird observatories (e.g., Manomet, Point Reyes Bird Observatory) and aid in their development and promotion.

14. The ornithological societies should establish training programs in basic ornithology and research techniques for amateurs. Amateur-oriented workshops supervised by professionals should become a regular part of annual meetings.

15. Annual meetings of the ornithological societies should be better structured to promote contacts and communication between amateurs and professionals and between junior and senior members. Part of this goal can be reached through Recommendation 14, but this will not be sufficient. Explicit procedures should be devised, such as scheduled round-table discussions, that will overcome diffidence or reticence and automatically put amateurs and professionals and junior and senior members in personal contact in an arena of common subject-matter interest.

From ASC Newsletter 6(5): 53–54, 1978.
(Association of Systematics Collections)

IUCN Views on Whale Management

The International Union for Conservation of Nature and Natural Resources (IUCN) is committed to the sustainable use of natural resources, including the living resources of the seas. It believes that it is possible to manage whaling on a sustainable basis and is concerned, therefore, that after three years the International Whaling Commission's (IWC's) *New Management Policy* has not been able to achieve this goal.

Although the IWC and its Scientific Committee have made commendable efforts to improve management procedures, the outcome has been generally unsatisfactory and there have been some extraordinary lapses; for example, the manner in which the quota for North Pacific Sperm Whales was sharply raised in December last year on the basis of questionable data and an inadequate model.

The IUCN is also deeply concerned that certain member states so far have not met the IWC's requirement that full and accurate data and analyses be furnished to the Commission. Those few states complying find their data subjected to intense scrutiny while those not complying may be awarded quotas in line with past custom rather than with the present conditions of the stocks. The work of the IWC is undermined by member states when they do not provide requested data and when they encourage whaling activities of non-members and report less than their total catch. IUCN suggests to the IWC that, to end such practices and to allay suspicion, it requires its members to provide original catch records and it re-opens discussion of the possibility of placing truly international observers, accredited by the IWC, to all whaling operations.

IUCN urges the IWC and member states

— to ensure that the quotas they set this year are conservative, particularly with respect to those stocks about whose status there is considerable doubt and those stocks which are part of multi-species fisheries;

— to ensure that current management policy is thoroughly revised in time for greatly improved procedures to be applied in 1979;

— to make good their commitment to gather

adequate data on whales and the ecosystems of which they are part by implementing without further delay the International Decade of Cetacean Research;

— to accelerate the revision of the Convention and ensure that its conservation provisions are considerably strengthened and the needs of whale conservation adequately catered for in related instruments for the management of marine resources.

Failure to take these measures will confirm IUCN and the rest of the international community in their view — expressed repeatedly since 1972 — that there is no rational alternative to a moratorium on commercial whaling.

With the support of the United Nations Environment Programme and the World Wildlife Fund, IUCN has embarked on an expanded program for marine conservation. Three of the objectives of this program are to launch an international system of cetacean sanctuaries, promote the conservation of the living resources of the southern ocean, and develop improved principles and procedures for the management of whaling.

IUCN welcomes the participation of the IWC in the operation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and hopes that through this and other joint endeavors by concerned governments and international bodies the current problems of the conservation of whales will be satisfactorily resolved.

From IUCN Bulletin. New Series 9 (7/8), July/August 1978.

"To Know Ourselves"

The history of Canadian science and technology is still being so badly neglected by our universities that "Canadian students know virtually nothing about their scientific heritage," says Thomas Symons, chairman of the Commission on Canadian Studies.

As a result, Symons said in a recent interview, "the technologists and scientists of the country are often underutilized and underestimated by their fellow citizens. A great deal of major scientific and technological work is commissioned outside the country because there just isn't the realization that we have the capability to do it here." Symons is the author of the Commission's 1975 report, *To Know Ourselves,* one chapter of which was devoted to science, technology, and Canadian studies.

The Science Council of Canada is preparing an "issues paper" on science and education in the Canadian context. A recent Council-sponsored seminar concluded that there is, at present, "no formal requirement and little interest in putting Canadian content in science courses." In anticipation of a possible full-scale study in the future, the issues paper will attempt to define and to focus on a number of the serious science-and-education problems highlighted in the Symons report.

Symons said he is encouraged by the fact that half a dozen universities have discussed with him the possibilities of either introducing or extending programs in the history of science. A major conference on the history of science was planned for Queen's University in November 1978. He also said there is some evidence that the attitude of Canadian scientists has been shifting in favor of the idea of Canadian content in science teaching. This shift has, perhaps not surprisingly, been most pronounced in the environmental sciences.

In his report, Symons acknowledged that science is universal and international, but he also argued strongly that it nevertheless has a "national and cultural dimension . . . Science is a key ingredient in the cultural fabric of our society." He suggests that there are "Canadian perspectives, Canadian applications, Canadian motivations (and) Canadian approaches to science that could be described accurately as Canadian studies."

His report in fact contains a litany of scientific subjects that could easily, and without rationalization, be classified within the ambit of Canadian studies — subjects which the Commission felt were being woefully neglected. For example, it urged that more attention be paid in science education to the implications of Canada's weather and climate; to marine sciences concerned with the continental shelf and offshore conditions; to the geology and geography of Canada's land masses; to Canadian mammals; and to Canada's forests.

The report particularly emphasized the lack of research in and about the North and the need for a more sustained and indigenous scientific effort there. It strongly recommended that a university of the North, or at least its nucleus be established immediately.

The Commission also argued that non-science students in university must be given some training in science and the history of Canadian science. This is needed "to equip non-science students with a better knowledge and understanding of the important part played by science in our society . . . As matters now

stand, universities in Canada are producing each year thousands of graduates whose knowledge and understanding of the role played by science in our total culture is minimal to zero."

Conversely, science students must be allowed to take courses in the arts and humanities that will give them a basic knowledge of the society in which they live and the social institutions which will inevitably affect scientific research.

Achieving this goal is obviously not an overnight kind of problem, but Symons said that a "modest beginning" has been made; a number of universities have indicated to him that they are taking a "fresh look" at the problem.

On the whole, in fact, Symons conveys a generally optimistic message. Although much remains to be done, he feels the Commission has been successful in prodding the scientific community to think about these issues. He also believes that the fact that he is not a scientist, and therefore could not be accused of self-pleading, helped in getting a fair number of the recommendations acted upon.

From Agenda, August, 1978.
(Bulletin of the Science Council of Canada)

Second Annual International Wildlife Film Festival

To encourage the production of high quality wildlife films, the University of Montana Student Chapter of the Wildlife Society sponsored the First Annual International Wildlife Film Festival last year. It was a great success and the chapter is again hosting this event. A panel of highly qualified film makers and biologists will judge films pertaining to wildlife and present awards and recognition to the winning films.

The deadline for submission of applications and films is 7 February 1979. All entries must have a predominantly wildlife theme and have been produced or released in calendar year 1978. Judging will be held on 10 and 11 February and the winning films will be shown on 3 and 4 March at the University Center.

Information, rules of eligibility, and application forms can be obtained by writing: *Wildlife Film Festival, Wildlife Biology Program University of Montana Missoula, Montana 59812 (Telephone (406) 243-5272).*

Book Reviews

ZOOLOGY

A Guide to Bird Finding East of the Mississippi

By Olin Sewall Pettingill, Jr., with illustrations by George Miksch Sutton. 2nd Edition: 1977. Oxford University Press, New York. xxvii + 689 pp. U.S. $15.95.

When I first began watching birds almost 20 years ago, one of the first books I acquired was O. S. Pettingill's *A Guide to Bird Finding West of the Mississippi*, published in 1953. This book and its eastern counterpart, published in 1951, have been constant and valued companions during my travels throughout the United States. Now a new and extensively revised version of the eastern guide has been issued, and a welcome event indeed this is for birdwatchers. Pettingill is presently revising the western guide, with a tentative publication date set for 1980.

The format of the book is the same as in the first edition. Following a brief introduction, it is divided into 26 chapters, one for each American state lying entirely east of the Mississippi River (except that Connecticut and Rhode Island are dealt with together, and the New York City region rates its own chapter). Canada is not covered, although several Canadian localities near the U.S. border (e.g., Point Pelee, Ontario and Grand Manan Island, New Brunswick) are discussed under the nearest state. Chapter length varies from 16 pages (Vermont) to 48 pages (Florida). Each chapter consists of two parts: a general account of the state's birdlife, and a list of specific bird-finding localities, which are discussed under the nearest sizable city or town. Each locality account includes detailed directions for reaching the area and a partial list of birds to be expected, with emphasis on uncommon or spectacular species or noteworthy bird concentrations. Both the general state accounts and specific locality accounts, especially the latter, have been revised substantially from the first edition. As Pettingill notes, the changes in 25 years have been profound, many bird-finding localities have been "developed," and the distribution of the birds themselves has changed in many cases. Thus some localities have been dropped from the new edition, but many others have been added; in Michigan, for example, 29 localities are described (under 18 cities and towns) in the new edition, versus 16 in the old edition. Locality accounts are generally briefer in the new edition, but for most states, the net result is better coverage overall.

The introductory sections in each state chapter are especially illuminating. Pettingill begins with a description of the physiographic regions of the state and their associated vegetation and land-use types. Then come lists of characteristic breeding species for major habitats, with notes on those species that are restricted to certain parts of the state. Next follows a description of bird migration patterns (spatial and temporal) in the state, and finally a brief account of winter birdlife. Having thus "set the stage," Pettingill then fills in the details in the individual locality accounts which follow.

The book's index is designed for easy location of information on a particular species. Suppose you want to find Bachman's Sparrows in Alabama. A glance in the index under "Bachman's Sparrow" tells you that the species is mentioned in Alabama locality accounts on pages 9 and 20; thus you need not wade through the entire Alabama chapter.

For English names of birds, the book follows the *A.B.A. Checklist*, published by the American Birding Association in 1975. Many of these names have not yet been adopted by the American Ornithologists' Union, and are not yet in general use; however, as the A.O.U. will likely adopt most of them soon, their use by Pettingill may help to prevent the book from becoming rapidly out-of-date. (The first edition includes some names now long obsolete, such as "Holboell's Grebe" and "Duck Hawk.")

The route directions in most cases are necessarily brief. But I have not experienced the difficulties encountered by one reviewer (J. A. Tucker, 1977, *Birding* 9: 226–231) in following them. The birder would certainly be advised to have a good road map handy, especially when trying to find localities in and near large cities. Given the frequent changes in road locations and numbering systems, however, directions for reaching some areas are bound to become out-of-date rather quickly.

In looking closely at the chapter on Mississippi (the state I know best), I noted a couple of typographic errors in place-names, and several errors of fact, mostly concerning bird distribution; however, such errors are few and of minor importance. If I do have any serious criticism of the book, it is that, for some states at least, the author has relied too heavily on old information. (For instance, of 14 persons cited as contributing information for the Alabama and Mississippi chapters, only two were not cited in the 1951 edition.) I am not suggesting that some of the areas included are no longer good for birds—only that local

observers now know of better and more accessible areas than some of those included. But I hasten to add that the selection of localities to include in a book like this is difficult and arbitrary, and no such selection will please all observers.

I have now had a chance to use the new "Pettingill" in seven states, and I unreservedly recommend it to anyone looking for birds in the eastern U.S. Although there are now many good bird-finding guides for individual states, Pettingill's is the only one covering the entire eastern part of the country, and I doubt that his approach will ever be significantly improved upon. Pettingill is to be congratulated on producing a well done and much needed revision of a book which is already considered a classic. My only lament is — when will someone write a bird-finding guide of similar comprehensiveness and authority for Canada?

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The Birds of New Brunswick

By W. Austin Squires. 1976. New Brunswick Museum, Saint John, New Brunswick. Second Edition. v + 220 pp., illus. No price given.

Ce livre est une nouvelle édition complètement revisée de celle de 1952 épuisée depuis plusieurs années. L'auteur y présente, en 221 pages, la situation ornithologique du Nouveau-Brunswick. L'ouvrage est agrémenté de dix photographies en couleur et autant en noir et blanc; le choix est judicieux et intéressant. J'ai apprécié particulièrement celles du Martinet ramoneur, de la Sitelle à poitrine rousse, du Grand Puffin et du Pic à dos noir. La bibliographie est complète pour la période séparant les deux éditions; il est regrettable que l'on ne retrouve pas dans cette nouvelle édition, toutes les références bibliographiques utilisées dans la première. Deux index, un regroupant les noms anglais et scientifiques suivi d'un second pour les noms français, indiquent le caractère biculturel de la province. Grosso-modo, le livre peut être divisé en deux sections: l'une traite de différents aspects de l'ornithologie dans la province et la seconde, constituant la majeure partie de l'ouvrage, est une liste annotée des oiseaux.

Dans la première section, l'auteur, en plus d'introduire la liste annotée, fournit quelques courts chapitres sur des sujets aussi divers que l'histoire, la biologie, l'écologie et la protection des oiseaux tout en limitant sa discussion à la province. Le chapitre sur l'histoire de l'ornithologie est l'élément le plus original. L'auteur cerne très bien le développement de l'ornithologie de 1613 à 1952; cependant, la période de 1952 à nos jours, période où l'ornithologie-amateur contribue de façon importante au développement des connaissances sur la distribution des oiseaux, est déficiente. Ainsi, il aurait été intéressant d'avoir des renseignements sur les groupes d'amateurs et de professionnels oeuvrant dans le domaine. A certains endroits de ce chapitre, il est difficile de distinguer entre les dates de visites des personnages et celles du système de références bibliographiques; une typographie différente faciliterait la consultation. Lors de la révision de l'édition originale, on aurait dû apporter une attention particulière à la conversion des mesures dans le système international (SI). Une carte de la province représente cinq régions topo-climatiques, les comtés provinciaux et quelques repères géographiques importants. Un lecteur, non-résident du Nouveau-Brunswick, apprécierait une carte avec une toponymie plus complète en relation avec la liste annotée. Ainsi, je n'ai pu localiser Pointe Lépreau, localité fréquemment mentionnée dans l'ouvrage; de même que l'île Nantucket, homonyme de la célèbre île au large du Massachusetts. Les autres chapitres de cette section sont intéressants: l'introduction et les chapitres sur la migration, la collection et la terminologie de la liste annotée doivent être consultés avant la lecture de la seconde partie de l'ouvrage.

Cette seconde section fournit une liste annotée de 345 espèces d'oiseaux. Dans la présentation de ce genre de listes, deux approches peuvent être utilisées; l'une consiste à décrire l'espèce, son habitat et quelques traits de sa biologie, suivi de son statut provincial ou régional. C'est l'approche que l'on retrouve dans des ouvrages concernant d'autres provinces canadiennes (Salt, W. R. et J. R. Salt, 1976, The birds of Alberta; Tufts, R. W., 1961, The birds of Nova Scotia). L'autre présentation consiste à se limiter au statut de l'espèce, en le précisant par une sélection de mentions. C'est cette dernière approche qu'utilise Squires et, à mon avis c'est celle qui atteint le mieux les objectifs que ce genre de livre devrait avoir. Dans la présentation de chaque espèce, les noms anglais, français et scientifiques sont fournis suivis d'un bref résumé du statut et de l'abondance selon des termes préalablement définis. Pour la majorité des espèces, une brève description de l'habitat et une sélection de mentions typiques viennent préciser l'abondance. Deux autres paragraphes décrivent

respectivement la distribution générale et provinciale. Enfin, les dates de ponte pour les nicheurs et la période de résidence de l'espèce au Nouveau-Brunswick terminent le traitement de chaque espèce. Ce genre de présentation agrémente la consultation de cette liste. L'auteur a fouillé en profondeur la littérature concernant les mentions pouvant se rapporter au territoire considéré. Cependant, le traitement d'espèces marginales, quoique précis, souffre d'une déficience bibliographique. Ainsi, l'auteur aurait pu faire le rapprochement des invasions de Vanneau huppé en 1927 et 1966 avec celles des provinces voisines; les mentions de Fauvettes azurées pour le Québec sont basées sur des spécimens (Ouellet, H., 1967, The distribution of the Cerulean Warbler in the province of Quebec, Canada, Auk 84: 272–274) et non uniquement sur des observations visuelles. Le traitement des espèces occasionnelles et accidentelles donne souvent prise à la critique dans ce genre d'ouvrage; cependant, l'auteur les aborde cas par cas avec un jugement critique.

Cette seconde édition est présentée sur papier de qualité avec une typographie claire et dégagée. Je n'y ai relevé que quelques erreurs typographiques; la seule importante est la référence bibliographique de Tufts (1961) concernant le spécimen d'Ibis blanc. Enfin, je considère que cet ouvrage est indispensable à ceux qui s'intéressent à la distribution des oiseaux dans le nord-est de l'Amérique du Nord et particulièrement au Canada.

PIERRE LAPORTE

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Mountain Monarchs: wild sheep and goats of the Himalaya

By George B. Schaller. 1977. University of Chicago Press, Chicago. 425 pp., illus. US$25.

According to the author, *Mountain Monarchs* is "a companion volume to *The Deer and the Tiger* in which I treated the ecology and behavior of some large mammals of peninsular India." For *Mountain Monarchs*, Schaller restricts himself, geographically, "to the Great Himalaya of Nepal and India, and to the ranges of Pakistan," and to the subfamily Caprinae.

"Rather than concentrating on one kind of animal in one locality for years, in the accepted manner of current ungulate studies, I moved from area to area, spending one month with one species, then the next one with a different species." This approach, coupled with a fairly extensive literature review, allows Schaller to discuss a variety of caprine species from a comparative standpoint. It is this comparative treatment of the species that makes the book enjoyable reading.

In reviewing the Caprinae, Schaller comments on taxonomy, distribution, physical attributes, population dynamics, herd dynamics, predators, aggressive behavior, courtship behavior, mother–young relations, and social behavior. Chapters I found particularly interesting were those dealing with "Herd Dynamics," "Aggressive Behavior," and "Courtship."

"The basic unit in caprid society consists of a female with her offspring. All other social systems represent permutations of this basic theme." "Most Caprinae herds are open, in that animals join and part, often when population density is great and not as often when it is sparse." Neither of these comments alone is particularly profound; however, they are significant in that they provide confirmation of caprine behavior not previously studied.

Chapter 9, dealing with "Aggressive Behavior," is probably the strongest and most thorough chapter in the book. It represents a significant review of aggressive behavior and provides comparative data for species inhabiting the Himalayan region.

Chapter 10, dealing with "Courtship Behavior," is not as well organized, but is equally thorough. By comparison chapter 11, "Mother–Young Relations," is far from thorough. It is probably the weakest section in *Mountain Monarchs*.

The last chapter is somewhat of a summary chapter. "When one looks for correlations two environmental variables obtrude: (1) species live longer in a habitat with a predictable food supply, and (2) species dwelling on and around cliffs live longer than those on flat to rolling terrain." Schaller's work is intended to provide some basic data on the status of unknown big-game populations in Asia. It is his hope that conservation efforts to preserve these species will be soon forthcoming. "In writing about this vanishing mountain fauna I feel a special urgency. All too often in history the last of a species has disappeared into the belly of a hungry hunter, its epitaph a belch."

PETER CROSKERY

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Précis de Zoologie: Vertébrés. 3 — Reproduction, biologie, évolution et systématique. Oiseaux et mammifères

Par P. P. Grassé. 1977. Masson, Paris. 2e édition. 395 pp. $35.00.

Ce volume fait partiellement suite au Précis de Zoologie, Vertébrés, de la même collection, qui réunissait Anatomie comparée, Biologie et Systématique. Afin de présenter les faits avec plus d'ampleur et d'offrir un aperçu plus fidèle de l'état actuel de nos connaissances, l'ouvrage a été divisé en trois volumes indépendants et sensiblement augmentés.

C'est un livre de format pratique (16 × 24 × 2 cm; 1 kg), très bien relié et d'une solidité qui devrait résister à l'usage le plus soutenu. En feuilletant le livre, j'ai été favorablement impressionné par la qualité du papier glacé et la clarté du texte imprimé. Il y a plusieurs dessins à l'encre de chine, quelques photographies noir et blanc un peu floues ainsi qu'un croquis en couleur qui n'apporte toutefois rien à la compréhension du texte.

Le présent livre traite de la reproduction, de l'évolution, des particularités physiologiques, de l'éthologie et de la systématique des classes des oiseaux et des mammifères. La partie qui concerne les oiseaux occupe le tiers du livre, celle qui traite des mammifères occupe le reste. On y décrit en détail les particularités anatomiques de ces animaux. Par exemple, l'auteur fait une excellente description des adaptations morphologiques qui permettent aux oiseaux de voler. Une section moins importante est consacrée à la systématique. On y présente les caractéristiques anatomiques ainsi que quelques aspects des moeurs des principaux genres. Malheureusement, les descriptions sont peu détaillées et le lecteur ne peut pas tellement s'imaginer l'allure des animaux décrits. Enfin, une section est consacrée au comportement. Cette partie de l'ouvrage est très décevante; le choix des sujets a été fait de façon arbitraire et chacun des aspects comportementaux sélectionnés est traité sommairement.

Le volume contient aussi quelques hors-textes: un avant-propos, une table des matières et un index alphabétique des sujets. Cet index est très bien fait et permet de trouver rapidement les informations désirées. L'auteur n'a cependant pas incorporé de bibliographie à son ouvrage, ce qui constitue une lacune importante puisque ce traité ne couvre que superficiellement la majorité des sujets.

En conclusion, malgré mes remarques critiques, je crois qu'il s'agit tout de même d'un ouvrage didactique de qualité, du moins en ce qui concerne l'enseignement de la morphologie et de la systématique des oiseaux et des mammifères. Quant aux moeurs de ces animaux, le lecteur y trouvera une foule d'informations qui l'aideront à s'en faire une bonne idée.

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Ways of the Six-Footed

By Anna Botsford Comstock. 1977. Cornell University Press. Ithaca. xii + 152 pp. U.S. $5.95.

This reissue of the 1903 edition is subtitled on the dust jacket: "A delightful introduction to the world of insects" — so it is! The author's poetic yet intricate description of the lives of a few common insect species provides the reader with new insight into the lives of insects. The ten chapters cover such subjects as sound communication, the Maple-leaf Cutter, mimicry, socialism, the Mud Dauber and Mason Wasp, the Carpenter Bee, the Basswood Leaf-roller, the Lacewing, the Seine Maker (*Hydropsyche*), and the Seventeen Year Cicada. There are 47 illustrations, many of them the author's, for, as stated by Edward H. Smith in the new foreword, "she became one of the foremost wood engravers of her time. . . ."

Not only did she illustrate books for her husband, John Henry Comstock, but co-authored several, as well as publishing some of her own. Her purpose in writing the stories in the present volume was to illustrate the truth that "wherever there is life there are problems confronting it; and that the way of solving these problems has been the way to success in the evolution of a species."

The author has dedicated her book "to all those who have been my good comrades and fellow loiterers in nature's byways" and it is to these people, or, in other words, all naturalists, that I would recommend this book.

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Birds of Southeastern Michigan and Southwestern Ontario

By Alice H. Kelley. 1978. Cranbrook Institute of Science, Bloomfield Hills, Michigan. vii + 99 pp., illus. Paperback US $2.95.

Alice Kelley's book is the latest regionally specific reference on birds in Canada and adjacent United States. Records of birds are taken from the area bounded by Kettle Point on the southeast end of Lake Huron, Rondeau Provincial Park, Toledo, and Flint. The author includes a brief four-page description of the topography, drainage, soils, status of forest and marshland, and areas of particular ecological interest.

Although short on illustrations, consisting solely of a map of the region surveyed, the book is long on detailed bird records, providing data on 338 species for the period 1945 to 1974. Each species is listed with abundance rating, residency, record arrival and departure dates, average arrival and departure dates, exceptional sightings and abundance records, breeding status, and locations and sites historically favored to viewing the birds.

One of the main objectives of Alice Kelley in writing the book is to document the historic changes in bird occurrence in order to monitor effects of rapid environmental alterations. Therefore, the book is written primarily for the seasoned birder/ornithologist who has advanced beyond basic identification to the point of determining geographic or ecological significance of particular bird sightings at specific locations.

Two disappointing features of the book are these:

(1) the 15- × 23-cm format which is unsuitable for most pocket sizes and therefore relatively inconvenient to carry in the field as a complement to most field identification guides;

(2) as the author suggests, the general qualitative statements regarding abundance and status have not been rigidly defined in quantitative terms. In 1954, the New York State Federation of Bird Clubs outlined numerical standards for qualitative terminology, and these could have been incorporated into the report as extensive quantitative data were available. This arbitrary system of abundance rating would invalidate most comparisons with those reported in other regional summary accounts using the established standards (e.g., *History of the birds of Kingston, Ontario* by Helen Quilliam).

Disregarding these minor detractions, *Birds of southeastern Michigan and southwestern Ontario* is a first-rate, comprehensive, regional documentation of birds recommended for those wishing to apply greater significance to their bird sightings and possibly contribute meaningful records for that region.

BRENT BEAM

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Watching Sea Birds

By Richard Perry. 1975. Taplinger Publishing Company, New York (Canadian distributer Burns and MacEachern, Toronto). 230 pp., illus. $13.25.

There were few books written on the natural history of seabirds of the British Isles in the 1940s that were better, or contributed more to the subject area, than Richard Perry's *Lundy, Isle of Puffins* (1940) and *Shetland Sanctuary* (1948). The information contained in these publications was extensive and important at the time; included were precise documentations of the breeding activities of colonial-nesting seabirds at two major sites and numerous unique interpretations of their biological significance. Thus, the republication of these long out-of-print classics under the title *Watching Sea Birds* is a most welcome event and will allow general readers and students of seabird biology an opportunity to gain easy access to otherwise scarce sources of very useful material.

The volume under review is a straightforward reprint of the earlier works containing the identical text with only minor editorial changes, usually most evident by the removal of out-dated or technically unacceptable sentences and paragraphs. The first half presents the main chapters from the Lundy book on spring occupancy, Atlantic Puffins, Black-legged Kittiwakes, Razorbills, and Common Murres, while the remainder comprises those from the Shetland book on Great Skuas, Arctic Skuas, Northern Gannets, and northern Common Murres. These accounts are the results of intensive studies conducted by the author from 20 March to 7 August 1939 on Lundy Isle in southwestern England and on the Isle of Noss, in the Shetland Islands, from 2 April to 18 September 1945. They provide a detailed and accurate description of the breeding biology of the various species, with particular emphasis placed on behavior, and most of the material covered is as significant and

informative today as it was when first produced. Together, they present a vivid and authoritative account of a community of seabirds made by an astute field observer and go far in capturing and translating the very special atmosphere associated with the study of colonies of seabirds and their islands.

There are, however, a few things wrong with this new version; for the most part these are errors in editorial judgment. The flagrant attempt by the author and/or publisher to disguise the reprint as a "new" book by not pointing out the existence of the original works or even the years in which the studies themselves were made (nowhere are the years given) was unwise and totally unwarranted. Although this decision was undoubtedly based on marketing considerations, it is difficult to understand how it came about; if anything, the potential for sales should have been enhanced by announcing the volume as a reprint of the earlier books, especially since copies of the originals are difficult and costly to obtain. The omission of all the photographs used to illustrate the earlier books is unfortunate, especially those in the Lundy book, which were carefully integrated with the text to show precise features of certain breeding activities. The substitute black-and-white ink sketches of birds in flight and on land by Richard Richardson do not fill this gap and are, in general, uninspiring and often inaccurate, adding very little to the book. Also, the decision not to reprint the summaries of the breeding schedules for individual species or the appendices (these contain statistical data on nesting and timing, etc.) is hard to accept. A judicious selection for inclusion should have been possible and would have ensured a still wider audience by increasing the value of the new version to both the seabird specialist and serious naturalist. As it now stands, these readers must of necessity go back to the originals for this information.

The major shortcoming, however, is the absence of an epilogue by the author to relay his assessment and personal feelings to the reader concerning the significance and implications of the large reductions in alcid populations that have taken place at his study colonies over the last 30 years. For example, the total number of puffins, razorbills, and murres at Lundy has decreased from about 33,000 breeding pairs in 1939 (from author's census) to less than 2300 pairs at the present time, with the puffin population virtually extinct (about 40 pairs in 1969–1970). Perry has unfortunately lost a great opportunity to add to the biological record of the populations that he first identified and so carefully appraised. This oversight can only be regretted by those of us concerned about the future welfare of this most threatened group of specialized seabirds and of the richness and diversity of marine ecosystems.

Overall, this new book will serve as a reliable and accurate source of the descriptions of seabirds and their breeding activities, and it will be found to be informative and useful to the general reader.

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Bird Hazards to Aircraft: problem and prevention of bird/aircraft collision

By Hans Blokpoel. 1977. Clarke Irwin, Toronto, in association with the Canadian Wildlife Service, Evironment Canada and the Publishing Centre, Department of Supply and Services, Ottawa. 236 pp., illus. $9.50.

That both birds and aircraft may helplessly tumble to earth after colliding in mid-air has been known since 1912 when the first such fatality occurred. Since that time there have been at least 77 reported bird-aircraft crashes with over 100 lives lost. The total financial loss resulting from these crashes is in the order of $100,000,000.

In spite of these staggering financial and personal losses, and the certainty of future bird-aircraft crashes to feed the fears of the world's millions of flight phobic individuals (30% of the flying population is flight phobic for one reason or another), there has never been a comprehensive guide or manual on the problems of bird hazards to aircraft. Recognizing this fact and drawing on first-hand experience gathered in more than 10 years of scientific study on two continents, Hans Blokpoel presents us with a volume designed to ". . . deal with all aspects of the problem." This may sound like an ambitious goal but readers will find that Blokpoel's objective is met very methodically in *Bird Hazards to Aircraft* by (1) examining the biology of birds as it applies to the problem; (2) examining bird strike statistics to determine the characteristics of the problem; (3) examining engine designs and airports and their surroundings to see how present and future problems may be eliminated or alleviated; and (4) producing references and organizations for further consideration. *Bird Hazards to Aircraft* is written and intended for those directly concerned with the

problem, regardless of their speciality. It is very readable.

Bird strikes generally occur to the engine of an airplane, at night (based on strike rate), during the spring or autumn migration, at heights under 3000 feet, during take off or landing (i.e., near airports), at aircraft speeds of 80–160 knots and, as in the 1912 crash, the species most often involved is a gull. Birds, however, have struck nearly all leading edges of aircraft, at any time of the day and year, at heights of up to 23000 feet, during all flight phases, at speeds of up to 260 knots, and strikes have involved birds as small as a Ruby-crowned Kinglet or as large as a Sandhill Crane.

From here Blokpoel discusses ways of bird-proofing aircraft and on-board means of diverting them from the path of aircraft.

Another approach to alleviating the bird hazard to aircraft is to reduce the attraction provided by airports. The most common attractants at airports are food and a safe place to nest or rest. Proper habitat manipulation can reduce both of these. Blokpoel says, "The airport should be made as much as possible into a monoculture, thus supporting only a few bird species against which effective scaring techniques can be developed."

Away from airports the main source of bird problems are from local and migratory flights. It is often possible to shift local bird flights by removing the birds' food sources or altering their roosting sites. Migratory movements of birds are much more fixed and Blokpoel discusses bird forecasting systems that have been devised to cope with large numbers of migrating geese and swans.

The concluding chapter and bibliography are excellent reference material. Listed are committees and individual names and addresses from 33 countries where the bird strike problem is being studied. The bibliography contains over 400 references and citations to other bird hazard/radar ornithology bibliographies.

The shortcomings of the book are few and only of a minor nature. I found that Blokpoel's occasional anthropomorphic reference made the book more readable; others may not agree. Some pre-1973 species spellings are still employed (e.g., Widgeon). The occasional technique is described without a reference given (e.g., p. 103). The Appendix, Table 1-3, on ground speeds of birds could obviously have been more complete (no gull species are given), especially where the original covered several journal pages. Those few shortcomings, however, are extremely minor and this excellent book should appeal to (and be required reading for) all those, ". . . directly involved in or concerned with bird strikes . . .".

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Bears — their biology and management

Edited by M. R. Pelton, J. W. Lentfer, and G. E. Folk. 1976. IUCN Publication, New Series Number 40. Morges, Switzerland. 467 pp. US $12.

Bears — their biology and management is a selection of papers from the third International Conference on Bear Research and Management. The text contains 45 papers with the papers grouped into 5 sections. The 5 sections cover bear behavior, bears in national parks, management of bears and techniques of management, status of bears, and biology of bears. The authors of the presented papers are international but approach common themes and problems.

The eight papers included in section 1 are all the result of observational studies on bear behavior. Bacon and Burghardt's paper, "Learning and Color Discrimination in the American Black Bear," points out that "black bears appear to use their eyesight during ingestive behaviors much more than previously supposed." Luque and Stokes' paper, "Fishing Behavior of Alaska Brown Bears," examines "brown bear fishing behavior, its development, and its relation to environmental and social factors." Other papers of this section deal with social behavior, breeding behavior, and threat behavior.

Section 2 contains seven papers, all concerned with bears in national parks. Papers of this section discuss people–bear conflicts, movement patterns of bears, territoriality, and bears and garbage. Beeman and Pelton's paper, "Homing of Black Bears in the Great Smoky Mountains National Park," demonstrates that "the probability of a bear becoming a nuisance other than in its established home range is quite low."

Although the papers of section 2 have strong management overtones, it is section 3 which contains papers classed as those dealing with management. This section contains 10 papers all of which are interesting. Two of the papers report on bear population control. Greer's paper, "Managing Montana's Grizzlies for the Grizzlies," suggests that hunting is not a big factor affecting grizzly popula-

tions, but were hunting eliminated the grizzly population could become a problem. Kemp's paper, "The Dynamics and Regulation of Black Bear *Ursus americanus* Populations in Northern Alberta," demonstrates that the adult males were affecting "a regulatory influence on the bear population."

Section 4, the *Status of bears*, contains 10 papers, mainly Eurasian in content and concerned with declining brown bear populations. Typical of papers contained in this section is Elgmork's paper, "A Remnant Brown Bear Population in Southern Norway and Problems of its Conservation." This paper points to one of the problems. "The most reasonable explanation for the relatively rapid decline starting in the second half of the 1950s is therefore not hunting and insufficient reproduction but the deterioration of the habitat caused by increasing human activity."

The biology of bears is the topic of the 10 papers contained in section 5. Some of these papers are strongly physiological in slant. Rogers and Rogers' paper, "Parasites of Bears: A Review," I found to be the most interesting paper of this section.

On a general level, *Bears — Their biology and management* contains a wealth of information. Those persons familiar with the 28 papers contained in the 1970 proceedings (IUCN Publication New Series Number 23) will note that these 1974 proceedings appear as a continuation of the earlier proceedings.

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The Earthworms (Lumbricidae and Sparganophilidae) of Ontario

By John W. Reynolds. 1977. Life Sciences Miscellaneous Publications. Royal Ontario Museum, Toronto. ix + 141 pp. $8.00.

It is with genuine pleasure that I welcome this guide to some of the lower forms of life, and at a reasonable price. It is regrettable that the title does not include all of Canada; however, the book does purport to be useful in southeastern Canada and the adjacent United States. I suspect that with care this publication would be useful in western Canada as well, for all but one of the nineteen species covered are introduced species. Further, fourteen of these species have been recorded from British Columbia. John Reynolds has authored numerous technical and popular articles on earthworms in a number of publications.

The foreword (from which I quote later) is by Ian R. Ball, Assistant Curator of Invertebrate Zoology, Royal Ontario Museum. Included in the book are an introduction to the general biology of earthworms, methods of study, an illustrated glossary, a key to species, species accounts, and a discussion of distribution and ecology of earthworms. The appendix includes a provincial description. The book is well documented, as indicated by fifteen pages of references. I have followed the author's instructions on the preservation of earthworms and have found the key workable.

Several pages are devoted to each species account, which is illustrated with line drawings and a map of the distribution in Ontario. For each species a synonymy, diagnosis, biology, range (in the world), North American distribution, and Ontario distribution are given. Common names are given in French as well as English.

I do not hesitate to recommend this book to anyone with an interest in the lower forms of life, especially to he who "finds his happiness unearthing worms."

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The Passenger Pigeon — its natural history and extinction

By A. W. Schorger. 1955 (reprinted 1973). University of Oklahoma Press, Norman (Canadian distributor Burns and MacEachern, Toronto). xiii + 424 pp. $7.50.

The University of Oklahoma Press has done the biological community a great service in reproducing this book. The Passenger Pigeon was an incredibly abundant species, perhaps the most abundant bird that ever lived. Its extinction is *the* classic disaster story of ecological and conservation literature.

Any species as abundant as the Passenger Pigeon (*Ectopistes migratorius*) is bound to invoke all sorts of legends. The decline of the Passenger Pigeon was close

to the point of no return when scientific investigations of bird behavior and ecology were in their infancy, and most ornithological journals were just beginning or not yet in existence. Thus, most information on the species was a jumble of fact and fiction scattered through old rare books, newspapers, and obscure journals. Schorger did an excellent job of compiling all this scattered data, and then sifting fact from myth. Myths are not simply dismissed, but usually explained as misinterpretation of facts. For example a habit of alighting on the ends of limbs of oak and beech to eat loose nuts that had not yet fallen caused the birds to winnow their wings back and forth to maintain balance. This resulted in a legend that they detached the nuts with blows of their wings.

The first chapter is appropriately devoted to early accounts. Seekers of Canadian content will be delighted to learn that the first known record of this bird comes from Prince Edward Island where Cartier saw an "infinite number" on 1 July 1574. The fifteen remaining chapters document behavior, food, use by humans, anatomy, distribution, and extinction. The last of these chapters is a critique of various drawings and paintings of the birds, based primarily on anatomical facts.

In general, the book is well written, easy to read, and remarkably free of technical errors. The caption and legend for Figure 1 lack any reference to the large nesting area shown on the map. The lengthy original quotes will be somewhat tedious to some readers, but a delight to others. Those of us interested in the history of science will find the 1685 quote on the physiology of "pigeon milk" in *Columba livia* fascinating, but it does seem a little out of place in this book. That the Passenger Pigeon existed in enormous numbers cannot be doubted, but the author's unhesitating acceptance that this was the most abundant bird ever known ignores similar estimates for the Red-billed Dioch (*Quelea quelea*) of Africa. The use of old and obscure sources with old place names resulted in some errors in distribution, at least in the prairie provinces. These have been corrected by C. S. Houston (*Blue Jay* (1972) 30: 221–222). One of the most useful features of the book for the serious biologist is the detailed documentation of sources. Some of these lack full publishing details.

To these minor criticisms, I would add only that the book is now over 20 years old. Serious researchers will need to consult recent literature for an update of information. Three more recent Canadian references that come to mind are those by Steele (*Canadian Field-Naturalist* (1967) 81: 172–174) for Ontario, Houston (*Blue Jay* (1972) 30: 77–83) for Manitoba and Saskatchewan, and Smith and Kidd (*Canadian Field-Naturalist* (1971) 85: 259) for Alberta.

Schorger's book is an excellent compendium of information that would not have been available without his decades of hard work. I recommend it highly to all ornithologists. To conservationists it will serve as an excellent example of the susceptibility of nature to human thoughtlessness. The fact that there exists only one known specimen of a nestling of what may well have been the most abundant bird ever known is shocking testimony to the lack of foresight by man in regard to this incredible bird.

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The Bird Finder's 3-Year Note Book

By Paul S. Eriksson. 1976. Paul S. Eriksson Inc., New York. pages unnumbered. US $7.95.

This 6- x 9-inch spiral-bound notebook is billed as a natural companion to a field guide for anyone wanting to maintain a permanent record of observations. Each day of the year is given one page. On this page, space is allotted for permanently recording observations for three years. The book provides an organized and orderly way to record year-to-year comparisons of migratory dates, behavioral characteristics, unusual observations, identification details, and other important notes that often become misplaced after the return from a field trip. Since the maintenance of field notes can be extremely important in future years and is often ignored by even the keenest field observer, any item that will encourage an observer to record his many worthwhile observations is important. Remsen (1977, On taking field notes, American Birds 31: 946–953) recently presented a thorough and enlightening discussion on why one should take field notes, how they should be written, and how they can be used.

At the bottom of each page is the inclusion of a quotation by a famous writer, an observation by Eriksson, or space for additional notes. Among the writers quoted are Peterson, Burroughs, Sutton, and Pettingill. A Peterson quote summarizes the importance of recording detailed field observations, "If exact numbers of each species are kept, a year-to-year

comparison gives a hint of increases or declines. Redstart — common does not mean much, but redstart — 58 does."

A special feature at the back of the book is a 10-page life list of more than 700 species listed alphabetically by their common and scientific names with space provided after each name for writing. Although this feature is an excellent idea, the list contains several errors that may confuse the user. Names are based upon the latest update (32nd supplement) of the A.O.U. Check-list, but usage is not consistent. Among the confusing names discovered in this section are Trudeau's Tern, a South American species (type specimen taken by Audubon in New Jersey); White Ibis, also listed as Spanish Curlew; Common Goldeneye, also listed as Whistling Duck; scientific name for Snow Goose given as *Chen caerulescens hyperborea;* Dipper listed under Ouzel, and Gray Hawk also listed as Mexican Goshawk. The treatment of the junco group is also very confusing. Misspellings spotted in the life list or diary sections are Gadwal for Gadwall, *Anus* for *Anas,* Widgeon for Wigeon, and *albifrans* for *albifrons.*

In summary, this type of diary may benefit many of us who find it difficult "to start from scratch" and to continue the endeavor of maintaining an organized record of field observations after a time.

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BOTANY

The Rare Vascular Plants of Ontario/Les Plantes Vasculaires Rares de l'Ontario

By George W. Argus and David J. White. 1977. Syllogeus Series Number 14. National Museum of Natural Sciences, Botany Division, Ottawa. 64 pp. English + 67 pp. French. Paper free.

The systematic conservation of our native flora requires current, accurate information concerning the distribution, abundance, and autecology of each taxon. Accordingly, taxa that are found to be rare and/or threatened can receive priority for conservation. Following this strategy, the Systematics and Phytogeography Section of the Canadian Botanical Association established a Rare and Endangered Plants Committee in 1973 to enumerate the rare and potentially endangered native plants in Canada. In concert with these efforts, the Botany Division of the National Museum of Natural Sciences initiated a project to compile a data base on rare and endangered Canadian plants. In the author's words, *The Rare Vascular Plants of Ontario* is "the first in a proposed series dealing with the rare vascular plants of the provinces and territories of Canada." (At the time of review similar lists in the Syllogeus Series were also available for Alberta and Nova Scotia.)

This publication presents a neatly abbreviated synthesis of information about the rare, native vascular plants of Ontario drawn from many sources: plant distribution maps, literature, IBP/CT checksheets, the examination of collections in the herbaria at the National Museum of Natural Sciences (CAN) and the Department of Agriculture (DAO), and the considerable input of botanists and naturalists knowledgable about the flora of Ontario, who were requested to comment on preliminary lists compiled from the preceding sources.

Specifically, the contents of this publication include an introductory section, an annotated list of rare plants, a bibliography, and three appendices. The introductory section briefly explains the history of the project, and gives definitions of rare, endangered, and threatened plants, the organization of the list, future plans for the continuation of this work, potential application of the list for the conservation of the Ontario flora, and notes about the distribution patterns of rare plants in Ontario. The considerable acknowledgments support the author's tenet "that no one person or group has sufficient knowledge of the flora of Canada to make a project of this magnitude a success without the support of all botanists and naturalists." The present work is a tribute to the authors' ability to marshal these human resources.

Although the authors supply definitions for 'rare,' 'endangered,' and 'threatened,' the present work, as suggested by the title, is clearly an enumeration of native vascular plants considered by the authors to be rare. 'Plant' is defined "to indicate collectively all the individuals referable to a plant name" including species, subspecies, and varieties. A 'rare plant' is defined as one that is restricted to "a small geographic area," or one that occurs "sparsely over a wide area." The authors have been cautious to avoid premature

designations of 'threatened' or 'endangered' in advance of objective information to defend such a designation, noting that for some plants "even information on rarity was scarce."

Pages 11–49 present an annotated list of 611 plants arranged in alphabetical order by scientific name. Where information exists brief notes are supplied for each plant including "synonyms, references documenting its status as a rare or endangered plant, its distribution in Canada and Alaska, its distribution in Ontario, references to published or unpublished distribution maps and comments on its status in Canada, special protection and other comments." The regimented format of this list suggests a computer application for processing future lists.

The reader is sure to be alarmed by the length of this list, which represents approximately 19 percent of the entire, native vascular flora of Canada. For many of these plants the center of distribution in Canada, or the entire Canadian distribution is restricted to southern Ontario where the pressures for habitat destruction are severe. For example, in a Canadian context, many Carolinian plants can be considered 'endemic' to Ontario. It may be appealing to suggest that the massive landscape conversion in southern Ontario since white settlement is a major reason for this high incidence of rare plants, but the essential historical documentation to advance this postulate is very inadequate.

Pages 50–63, inclusive, contain a bibliography in excess of 300 references and three appendices. Appendix I lists 36 plants reported to occur in Ontario whose status requires verification. Appendix II lists 21 alien or doubtfully native plants. Appendix III presents the list of rare plants in taxonomic order following *Gray's Manual of Botany,* edition 8.

The publication measures approximately 21.7 × 28.1 cm (8 1/2" × 11") and is neatly bound in soft cover with a stiff spine. The text is clean, free of typographical error, and organized into two columns to facilitate reading. Although the publication includes both English and French translations, the latter appears unjustified except for the Introduction on pages 1–11. The bibliography and appendices are identical duplicates in the two translations while only very elementary English or French translation skills are necessary to comprehend either translation of the annotated rare plant list.

Although traditional views concerning the protection of endangered species have focused on wildlife in a quite narrow sense, this publication is evidence of a broadening concern for the stewardship of our biological heritage. As the initial statement in a projected series, *The Rare Vascular Plants of Ontario* promises great potential to monitor and to update periodically a red list of the Canadian flora. In addition to being an incentive for botanists and naturalists to continue exploratory work towards a more comprehensive understanding of endangered plant life, this report serves as a catalyst to further the appreciation and the protection of our native flora. This significant work deserves the serious attention of all government agencies, private sector organizations and individuals concerned with biological conservation and landuse planning in Ontario.

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Fungi: Delight of Curiosity

By Harold J. Brodie. 1978. University of Toronto Press, Toronto. 131 pp., illus. $10.00.

Here is a book of many charms, but how does one classify it? It could scarcely be further removed from the textbook category, although written by a mycologist. It is certainly not science fiction, though the rank beginner or the skeptic might be excused for thinking so. The author states his aim frankly, to share his personal feelings of curiosity, excitement and delight when confronted with the complexity and perfection of devices in operation among the fungi as they compete for survival and propagation of their kind. Written not for students of the fungi, nor even for those with some background in biology, the book is addressed to the mycologically uninformed public. It avoids technical jargon, and describes phenomena of the fungus world in simple terms intelligible to nonbiologists.

Between Preamble and Postcript are eleven unrelated chapters, each complete in itself, describing strange fungi or curious features of fungus life. The chapters are bound together very loosely by the fable of the blind men and the elephant, illustrating the author's contention that most of us, limited by viewpoint and individual powers of perception, fail to perceive and appreciate many aspects of the natural world around us.

Some indication of the book's content may be gathered from reference to the topic of chapter one: Gunnery in the Fungus World. The common mold *Pilobolus,* a marvel of biological ingenuity, is an

example in nature of an automatically controlled missile. By mysterious manipulations of its chemistry, and making use of well-known principles of physics, the fungus has perfected a complex and efficiently designed apparatus for hurling its projectile (a pellet of spores) several thousand times its own diameter, actually directing the aim of the missile with over 80% accuracy. Equally intriguing is the subject matter of the other ten chapters.

Not the least of the delights of this book is the author's facility with English. With a few strokes of the pen, he evokes lively mental images of the unseen fungus world. It is a rare scientist, too, that can align his thinking with that of ordinary folk, to describe a fungus as "suggesting a broad vase filled with bananas," or again, to depict the fungus-gardening ant carrying big leaf fragments aloft "like a man carrying a sheet of plywood." The author's first finding of the Coral Fungus is described in a most beautiful piece of writing, revealing a fine-tuned sensitivity to sound, scent, color, and form. Throughout the book, an unexpected sprinkling of philosophy and folklore, wisdom and humor, make for enjoyable reading quite apart from the scientific information imparted.

The 22 black-and-white photographs of fungi have magnifications ranging from 1/2 × to 10000 ×. Also included are a simple glossary, a selected reference to books on related topics, and an index.

It is difficult to pigeon-hole this work, but there is no difficulty in recommending it as a delightful and unusual addition to one's natural history library.

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Pollen Flora of Argentina: modern spore and pollen types of Pteridophyta, Gymnospermae, and Angiospermae

By Vera Markgraf and Hector L. D'Antoni. 1978. University of Arizona Press, Tuscon, Arizona. 208 pp. US $9.50.

This publication provides photomicrographs, morphologic descriptions, and keys for 374 pollen types. It divided keys into four plant geographic regions to facilitate palynologic work in other similar areas. This text also includes indexes to plant families, plant species, and common names.

This much needed text will be very useful to people working in palynology and other disciplines in botany, not only in South America, but in North America, Europe, Africa, Asia and Australia.

I. JOHN BASSETT

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Floristics and Environmental Planning in Western New York and Adjacent Ontario — distribution of legally protected plants and plant sanctuaries

By Richard H. Zander. 1976. Occasional Paper Number 1, Buffalo Society of National Sciences, Buffalo, New York. 47 pp., illus. Paper US$2.50 + 35¢ handling.

The paper deals with a number of plants that have been given some protection by New York State law. All protected species, except for ferns, orchids, and club mosses are mapped on an individual basis. Many species are discussed in detail with emphasis on geographic distribution and preferred habitat.

This publication was obviously written by a botanist who is concerned about the long-term protection of rare plants and their habitats. This reviewer and most readers of *The Canadian Field-Naturalist* would agree with this idea.

The paper's strength lies in its botanical components. It is weak in its planning elements. The title is too broad for the material covered in the small publication. In reality the paper deals with rare plants and areas worthy of protection rather than floristics and environmental planning.

Zander mentions that Section 193.3 of the New York State Penal Code, "protects certain nature wildflowers, ferns and shrubs in New York State and provides for a small fine for picking, transplanting or removing any of them. However, it affords no protection to these plants from the owners of the land upon which they grow." Later he mentions that "the recently enacted state Freshwater Wetlands Law . . .

would give some protection from encroachment to wetlands over 12.4 acres in extent." These statements tantalize. It would have been worthwhile if the relevant sections of the law had been discussed in detail. Those who are working towards legislature changes to protect natural areas, elsewhere, would have appreciated such information.

The document is liberally illustrated with distribution maps. Each has a typical dot format which indicates the presence or absence of a species in a minor political district (townships, town, or city). It would have been better if each station of the uncommon plant had been indicated by a small dot at the appropriate site location, as was done in Fox and Soper's well read papers on Canada's Carolinean flora. Unfortunately, several of the maps have no legend and no reference back to the text page where some explanation does occur.

Now a few small points. Is Helleborine, *Epipactis helleborine*, actually so rare as to be a protected plant in New York State? In my experience in southern Ontario it is ubiquitous. In the Regional Municipality of Niagara there are important nature reserves that do not appear on the list. The Short Hills Nature Sanctuary, near Forthill, is owned and managed by the Hamilton Naturalists' Club. The large, new Short Hills Provincial Park has extensive blocks of important natural areas most of which are protected in the Master Plan.

Ideally, what would a planner or other decision-maker need in order to fulfill the expressed desires of this book? Let's list a few:

(1) A law allowing him to practice environmental planning in his area of jurisdiction.
(2) The written judgment of reputable botanists on which plants are worthy of protection and why they would be protected.
(3) Detailed maps showing the important botanical areas that need to be protected.
(4) Published data that supports the boundary delineations of the areas.
(5) Political (public) support when a land-use conflict threatens a delineated natural area.

This publication attempts to fulfill several of these points, most specifically 2 and 3. Each of these efforts listed above should be in place at a time well before any on-the-ground activity takes place. For example, most subdivisions in Ontario usually take 5 years from when the first approach is made to a municipality until construction starts. The later an environmentalist enters the planning flow the less likely is his possibility of success.

It is the melding of biological data and philosophies into the land-use planning regimes of our society that is now just getting off the ground, or should I say on the ground. Publications such as this one are efforts in that direction.

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Atlas of Airborne Pollen Grains and Spores in Northern Europe

By Siwert Nilsson, Joseph Praglowski, and Lennart Nilsson. 1977. Ljungföretagen, Örebro, Sweden. 159 pp. US $37.50: Sw Crs 170.

This is an excellent introductory text on airborne pollen grains and spores of northern Europe. The atlas contains descriptions and illustrations of more than 70 species utilizing light, scanning and transmission electron microscopy. The descriptions are accompanied by distribution maps and flowering period for each species. Many of the species described also occur in Canada and the northern United States.

Freshly collected pollen grains and spores were generally used. In some cases pollen was sampled from dried herbarium specimens located in the Botanical Section of the Swedish Museum of Natural History. The pollen grains and spores were embedded in fuschin-stained glycerol jelly and the cover slips on the slides sealed with paraffin wax. Preparations for scanning, transmission electron microscopy are clearly explained in the text.

It is unfortunate that there was no description of the equipment used to collect airborne pollen and spores. The amounts of airborne pollen and spores can be summarized more specifically by using one of the collecting devices now used in several countries. I doubt, for example, that the very minute airborne pollen grains from dandelion, *Taraxacum* spp. or from goldenrod, *Solidago* spp., would be caught in very large amounts.

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Orchid Biology: reviews and perspectives, I

Edited by Joseph Arditti. 1977. Cornell University Press, Ithaca. 310 pp. US $29.50.

Biology is a wide field of study, even if all the organisms studied belong to a single plant family. Even so, its meaning has to be stretched to cover the range of topics in this book. One third of the text is devoted to "A manual for clonal propagation of orchids by tissue culture." In this chapter, J. Arditti has gathered together all the techniques brought to his attention by the cut-off date: December 1974. Not only does he cite the original papers but also provides comments based on his own experience. As an annotated review of the literature it should be of some value to people in the area. The other articles seem of less value, either because they cover little new ground or because there is so little good information available. The account of the fossil history of the Orchidaceae appears to fall in the first category. To people like myself who have not read the Schmids' previous articles on the topic, published in 1973 and 1974 and cited here, their article is interesting and provides a useful warning on the perils of using secondhand sources of information. I am doubtful, however, of its value to students of orchids. The article on anthocyanins of the Orchidaceae falls into the second class: not enough information is available to justify the length of this section. Two other articles fall outside the bounds of orchid biology to my mind: an account of his involvement with orchids by R. E. Holttum and a discussion of Rumphius' contribution to orchidology by H. C. D. de Wit. I enjoyed them both as general reading, although that on *Rumphius* is, in my judgment, rather long. This article and the others would benefit from a more severe editorial hand. As it stands, the section on tissue culture techniques should earn this book a place on the shelves of orchid breeders and the title will recommend the book to ardent orchid devotees. It is perhaps only fair to admit that I myself am not one.

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ENVIRONMENT

Nature Quizzes for Canadians

By V. and B. McMillan. 1976. Douglas, Vancouver. 144 pp., illus. Paper $3.95.

The impetus behind this book evolved from a desire to assist Canadians in learning about their country's natural environment. I must admit, there are some interesting and informative chapters; however, the text is poorly organized and filled with errors.

The numbering systems employed to differentiate the questions are very poor. In many cases the numbers used to label the diagrams are also designed to double as question numbers. On page 89 the first seven questions are labelled alphabetically from a to g, while the remaining questions in the chapter read as numerics (8–20). Very confusing.

In the chapter examining the reader's knowledge of 'Immature Insects,' pictures of the adult forms, which the reader is asked to match up with the immature stages, are completely missing. On page 90 (question 11) the authors make reference to a diagram that does not exist.

I also found a question (#5, page 15) where the wrong answer, followed by a correct explanation, was recorded, thus causing a contradiction, which to a novice might prove confusing. On page 41 (question 20) the reader is asked to give the name of a northern freshwater fish belonging to the Gadidae. Directly below the question, not in the answer section where it belongs, is the answer, a labelled diagram of a burbot.

There is no consistency in the usage of nomenclature. I found three incorrect spellings: the red admiral butterfly (*Vanessa atlanta*) is not *Vanessa atalenta* (page 38); the moose (*Alces alces*) is not *Alcea alcea* (page 40); the muskrat (*Ondatra zibethicus*) is not *Ondatra zibethica* (page 49).

I feel that the concept is sound, and that the text has possibilities, but until the book is properly organized and the errors in composition are corrected, the book is not worth buying.

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The Shetland Way of Oil. Reactions of a small community to big business

Edited by John Button. 1976. Thuleprint Ltd., Sandwick, Shetland. 134 pp. £2.40.

This is an admirable little book. Although it deals with events in a faraway place, under a jurisdiction and an administrative system that differ from those in Canada, it offers much sensible advice, as well as stimulating examples of success, to all who care for more in the world they live in than just their own financial prosperity.

The most powerful reason for the recent setbacks suffered by the "environmental movement" has been the sustained demand for oil, despite the massive price increases imposed by the OPEC countries. Part of the western reaction was to intensify the search for other supplies. Their most substantial early success was the discovery of large quantities of oil and gas in the northern North Sea and the development of technology to extract oil from under the seabed at unprecedented depths. The nearest deep-water harbor to some of the most promising oil fields was found at Sullom Voe, off the Mainland of Shetland. So there the oil industry descended, with plans for the development of a storage facility for crude oil brought ashore by pipeline and later establishment of a refining plant too.

The fourteen chapters of this book, each by a different author, half of them local men, deal chiefly with the responses of the local communities to the potent and unexpected combination of opportunities and hazards. By great good fortune, the expertise and the affluence of the oil companies and their supporters in distant arenas of government did not altogether overwhelm the local talent. The Zetland County Council (now the Shetland Islands Council) quickly devised an Interim Development Plan. It succeeded in obtaining legislation (the Zetland County Council Act of 1974) which gave it powers exceptional for a local authority. The council now acts as the port and harbor authority for Sullom Voe; can acquire land for oil-related development within the designated area; issues licences to dredge (and may refuse to do so) and licences construction work within the three-mile territorial limit; may take shares in commercial undertakings; and may establish a Reserve Fund. With so strong a jurisdictional base the local people have been well placed to exercise control over undesirable development and have succeeded in doing so to a remarkable extent.

For naturalists the chapters by Peter Kinnear on "Birds and Oil" and by Brian John on "The Milford Haven Experience" are of greatest interest. Kinnear writes "The value that is placed on birds and other wildlife, which do not provide some immediate financial return, is to a large extent subjective. For many people the value might seem sufficient, but it cuts little ice with either Government or developers, who require a more qualified scientific appraisal. . . . One way of assessing the importance of Shetland's birdlife is to consider the number of different species and to see what proportion of the total British stocks they constitute." Fortunately for his chosen approach, those numbers are known and for several species do make up an impressive fraction of the British stock: 90% of the Great Skuas (*Stercorarius skua*) (or 50% of all those in the northern hemisphere) and 70% of Arctic Skuas (*S. parasiticus*); 90% of the Whimbrel (*Numenius phaeopus*), 1/2 to 2/3 of the Red-necked Phalaropes (*Phalaropus lobatus*), 1/3 to 1/2 of the Red-throated Divers (*Gavia stellata*) and so on, with nationally significant stocks of at least 24 species. Most of those species are marine and so directly at risk from oil pollution, from pipeline leaks, spills on shore, bilge discharge and tank washing by tankers and, eventually no doubt, tanker collisions or groundings. To look at the probability Kinnear turns to the detailed experience gained over the last fifteen years or so in and around Milford Haven, in west Wales, a major reception area for large tankers and "widely regarded as the cleanest oil port in the world." Milford Haven handled 53.1 million tons of oil in 1973. Sullom Voe is expected to handle 50 to 150 million tons annually over the next twenty years or so. In the eleven years 1963–1973 Milford experienced an average of 53 spills a year. Sullom can thus expect a similar or larger number, amounting to between 400 and 1200 tons a year, excluding any major accident. But, whereas Milford Haven is subjected to massive tidal flushing, Sullom Voe has only one eighth of Milford Haven's tidal velocity and only a fraction of its water is changed each tidal cycle. Building up of oil and other pollutants seems inevitable; and a major tanker accident is likely too, because manoeuvring very large tankers through Yell Sound "will always be a hazardous affair, particularly during fog and severe weather." Kinnear, however, sees the greatest danger to birds as likely to result from the continuing practice of discharging oily ballast water at sea (in order to save time at the terminal), an activity which it is often hard to detect and prove. He complains that British regulations governing pollution control are in dire need of change. "Although various laws restrict the discharge and dumping of oil in the sea, once there it is incumbent on no-one to do anything about it."

What lessons can naturalists in Canada learn from this book? First, in many areas now being explored for oil we still lack the basic inventories to establish numerically what birds are at risk, although great progress has been made along the eastern Arctic and

Atlantic coasts and offshore in the last decade. That task must be completed and the results made known to governments, the oil industry and the public, whether or not they want to hear about them. Second, the best hope for effective actions on behalf of wildlife lies in power being given to local people and in their vigilant and responsible use of those powers. (The Inuit seem to understand this more clearly than many people elsewhere.) Third, wildlife interests are most unlikely to be sufficient to prevent major economic developments, the equivalent of North Sea oil, from taking place; but they can and should make an important contribution to keeping the activities of exploiters cleaner than the latter would like, though not as clean as the birds require. So long as oil is taken from under the sea or carried across it, birds will be the losers.

"So we return to the moral question and the personal value each one of us places on birds and wildlife. While you decide how you are going to play your part in changing things, spare a thought for the vast numbers of birds which migrate at night and each year die in thousands, attracted by and consumed in the giant flames burning from the rigs across the North Sea" (page 99).

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EZAIM: écologie de la zone de l'aéroport international de Montréal — Le Cadre d'une recherche écologique interdisciplinaire

Par P. Dansereau. 1976. Les Presses de l'Université de Montréal, Montréal. Polycopié. 343 pp.

Comme a déjà dit l'un des chefs d'équipe impliqué dans cette étude écologique de la zone de l'aéroport devenu Mirabel, étude à priori multidisciplinaire: "on a l'impression qu'il n'y a que Dansereau qui fait du multidisciplinaire." Ce commentaire soulève à lui seul l'ampleur du problème de la communication entre des spécialistes de disciplines aussi variées que la psychologie, la géomorphologie, la zoologie. Ce même problème cède cependant le pas à la science elle-même à l'intérieur d'une même spécialité.

Ayant participé à cette étude, j'ai pu me rendre compte que le travail d'équipe fonctionnait au niveau de chaque équipe dans leur discipline propre, mais que le travail d'intégration multidisciplinaire ne semblait qu'être le fruit d'une démarche personnelle, celle de Dansereau. Ce dernier se veut cependant plus positif quant à la possibilité et la réalisation d'un projet multidisciplinaire et complexe à souhait.

L'étude EZAIM a été entreprise après le début des travaux de construction et d'aménagement de l'aéroport, ce qui soulève peut-être son caractère secondaire aux yeux des intérêts économico-politiques, problème soulevé par Dansereau lui-même en fin d'ouvrage d'ailleurs.

Le plan de recherche envisagé a été calqué sur l'écosystème lui-même, à savoir les différents niveaux trophiques entre lesquels ont lieu des interactions. Les équipes étaient donc divisées en géomorphologie, écologie végétale, écologie animale (mammifères, oiseaux), géographie humaine (utilisation des terres, industrie et urbanisation), psychiatrie sociale, sans compter les échelons nécessaires de coordination et d'administration.

Dansereau insiste sur le fait que cette recherche se veut une expérience, multidisciplinaire soit, mais expérience intégrée par l'auteur dans le contexte d'une "philosophie écologique" qu'il prône. Le chapitre 2 est peut-être à ce point de vue le plus important, car l'auteur y expose les définitions de sa démarche qui doit assurer la cohérence à la recherche (ou à toute recherche) qui s'attaque finalement à des écosystèmes très variés.

La définition élargie qu'il donne à l'écosystème est la suivante: "Un espace limité où le cyclage des ressources à travers un ou plusieurs niveaux trophiques est effectué par des agents plus ou moins fixés et nombreux, utilisant simultanément et successivement des processus mutuellement compatibles qui engendrent des produits utilisables à courte ou longue échéance."

Se basant sur cette hypothèse de travail, et par une description des relations qui interviennent entre les six niveaux trophiques (minéro-, phyto-, zootrophie (herbivorie, carnivorie), investissement et contrôle) dans des écosystèmes types, c'est-à-dire par une analyse écosystématique des paysages, il parvient à définir tout paysage d'un point de vue écologique. Cette analyse consiste en un inventaire des ressources présentes à chaque niveau trophique et des agents et processus ou forces motrices ayant court dans la transformation d'un niveau à l'autre ou d'un paysage à l'autre. Elle implique également la compréhension de l'aspect dynamique du cyclage dans chaque paysage pour mieux situer la stratégie régionale d'un point de

vue écologique, et mener ainsi à la construction de matrices d'impact qui devraient guider la planification.

Mais non content de l'analyse écosystématique de la zone de Mirabel, Dansereau débouche naturellement sur l'universel, soit lorsqu'il présente les régions phytotrophiques, dont celles applicables à Mirabel, soit lorsqu'il présente son nouveau système de classification des terres basé sur l'escalade de l'impact humain. Et ce sont justement ces visées universalistes qui font de cet ouvrage de Dansereau un outil de plus pour les études à caractère multidisciplinaire.

Toute cette philosophie écologique peut se résumer graphiquement par un "boule-de-flèches" (sphère qui contient les circuits de ressources, agents, processus et produits) qui illustre sa démarche. Cette démarche n'a pas été comprise par tous les participants du projet EZAIM, ou selon l'expression de Dansereau "a souvent été perdue de vue."

Du point de vue strictement de la présentation, les erreurs typographiques sont rares. Certaines figures ou tableaux sont incomplets: la légende de la figure 23 n'est pas rapportée entièrement au tableau XIII tel que mentionné. Le style est simple et clair, si ce n'est le vocabulaire scientifique propre au domaine du botaniste qui transpire tout au long de l'ouvrage.

On y trouvera aussi une autocritique, sûrement pas assez vive à mes yeux et à ceux de certains autres participants, du projet EZAIM tel qu'il avait été conçu par l'auteur du présent ouvrage et tel qu'il a été réalisé. Globalement, l'ouvrage rend davantage compte de ce que devrait être une recherche écologique interdisciplinaire à partie d'un modèle, plutôt que d'être une synthèse des résultats écologiques recueillis par chaque équipe. Ce qui retiendra notre attention sera ce modèle écosystématique de Dansereau, sa philosophie qui permettrait d'analyser tous les types de paysage selon un point de vue écologique, y compris les paysages humains et il faut, je crois rendre hommage à Dansereau pour sa vision synthétique du cadre qu'il propose.

On ne saurait trop recommander la lecture de cet ouvrage aux aménagistes et aux spécialistes à tous les niveaux trophiques, tant naturels qu'artificiels ou humains, tout au moins pour les changements dans les valeurs sociales qu'il prône pour les développements d'ordre socio-économiques à venir.

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Outdoors Canada. A unique and practical guide to our wilderness and wildlife

Edited by Douglas R. Long. 1977. Reader's Digest Canada Ltd. and the Canadian Automobile Association, Montreal. 383 pp., illus. $21.77.

Outdoors Canada is intended to assist Canadians to enjoy their out-of-doors. The book not only tells of the out-of-doors (mammals, birds, plants), but it also explains how to cope in the out-of-doors (camping, canoeing, backpacking). Photographs demonstrate what can be seen, while numerous drawings illustrate and explain the book's "how to" information.

Not all of the information in the section on wildlife is entirely accurate. Some notable inaccuracies would include these statements: "many fur bearing animals are near extinction" (p. 15); "most great whales are endangered species" (p. 13); "the distribution of porcupine is south of the treeline" (should read mainly within the predominantly hardwood forest areas). The section is far from complete but does present an interesting capsulized summary of most groups of animals found in Canada.

As noted within the text, birds are animals and are included within the animal section. The treatment given to birds is less complete than that given to mammals. Again some of the book's statements are questionable. One such statement to which some persons might take exception would be, "the whooping crane is North America's rarest bird." The section on birds will not serve as a field guide; however, it is enjoyable reading.

Whereas for the section on Animals the photographs tend to supplement the text, the reverse treatment is given to the section on Plants: photographs are supplemented by the text. Also, the Plant section tends predominantly to focus on flowering plants and generally those that are more common. Again this section will not replace a field-guide treatment as is popularly used by naturalists. Unlike the Animal section, this section appears disorganized.

The section on Camping covers the whole gambit of outdoor travel. This section is generally well organized, well presented, and contains much good advice. One comment I would caution the reader about is this: "to keep your feet dry in leaky boots or in shoes that are not waterproof, wear plastic bags over

socks." If the weather is cold, perspiration within the plastic bags could result in very cold feet (possibly frozen). As the book points out, "experience is probably the surest guide."

As surely as rules are made, there are exceptions. The section, "Outdoors: Just for Fun," suggests it is a good idea to stay with your canoe after it is capsized. But common sense should prevail and when swamped or capsized in white water, sometimes it is best to leave the canoe. On occasion, people have been known to get pinned between their canoe and rocks, resulting in serious injuries.

The last 49 pages of *Outdoors Canada* is a series of regional (Canadian) maps. These pinpoint the locations of various outdoor areas in Canada. A brief note explains the features of specific sites. This section will be of assistance to those persons planning a Canadian out-of-doors vacation.

Generally speaking, *Outdoors Canada* is very much a Reader's Digest-type book. It is a brief summary of material rather than a complete treatment. The book covers the whole spectrum of the outdoors and admirably does not get bogged down in any one section. For the inexperienced outdoors-person, it is an excellent buy.

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Why Big Fierce Animals Are Rare. An ecologist's perspective

By P. Colinvaux. 1978. Princeton University Press, Princeton, New Jersey. viii + 256 pp. $9.50.

In an informative and logical fashion Colinvaux presents the rudiments of ecology, and endeavors ..."to trace the status of the ecologist's quest" in a thorough examination of the numerous riddles of nature. Without obscuring the text with highly technical terms that might discourage the novice, he reveals concerns of modern ecologists, concerns nurtured by pioneers like Charles Darwin, G. F. Gause, and Charles Elton.

In 18 chapters he outlines the niche, biogeography, aquatic-terrestrial-atmospheric cycles, succession, coexistence, behavior, species diversity, environmental stability, and the evolution of man's role in nature. Page by page the ecological story unfolds as the author describes the efforts of men like Alphonse de Candolle, the last man singly to attempt to describe all of the known plants in the world; Vladimir Koppen, the climatologist who mapped world weather using vegetation zones; C. Hart Merriam, the explorer who devised the life zone concept; and Tansley, the English botanist who coined the word 'ecosystem.'

The subject matter is uniquely accented with a number of interesting anecdotes. For example, in chapter 3, entitled "Why Big Fierce Animals Are Rare," Colinvaux exposes the myth of *Tyrannosaurus rex* amidst a discussion of food-chain dynamics. He also dispels the fantasies of hope that evolved from the green revolution in a few short sentences: "It is a myth that is probably as impossible to eradicate as the myth that *Tyrannosaurus rex* was a ferociously active predator. But myth it is. Algae are not more productive than other plants."

I was particularly impressed with the final chapter, "The People's Place," in which the author reconstructs the story of man's climb to environmental dominance. But more than that, Colinvaux stresses the importance of man's dynamic role in the complex ecosystems of the earth, a role that beginning ecologists must understand in order to develop an appreciation for the relations among other living organisms and their environment.

The text is greatly enhanced by a section on ecological reading, which lists many excellent papers on the numerous subjects of the science. A useful index is also included. Unfortunately, the title of the book, *Why Big Fierce Animals Are Rare*, is misleading; in my opinion the title suggests that the book is about predator ecology, not a general overview of ecology. Nonetheless, it is well written, and is as complete a book as one would expect at the introductory level.

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OTHER

Northern Vagabond. The life and career of J. B. Tyrrell

By Alex Inglis. 1978. McClelland and Stewart, Toronto. 256 pp., illus. $14.95.

The author begins this interesting book by describing Joseph Burr Tyrrell's famous 1893 3000-mile trip through the central Barren Lands of Canada — one of the last great feats of exploration in Canada's history. When Tyrrell's party of eight set out by canoe from Fort Chippewyan they were not certain whether the Dubawnt and Thelon rivers, along which they planned to paddle, would carry them to Hudson Bay or to the Arctic Ocean; if the latter, their chances of returning alive were slim. Nor were they sure they would encounter game, largely Caribou, to feed them. Their inland exploration ended successfully at Chesterfield Inlet on Hudson Bay, but their trip was by no means over. They had yet to make their way through blizzards and ice along the coast for 400 miles to Fort Churchill, and from there walk and travel by dog sled the 900 miles to Winnipeg and the railway.

Tyrrell undertook this voyage while he was a geologist with the Geological Survey of Canada, a position he held from 1881 to 1898 although he had little formal training as a scientist. He spent his summers exploring the wilds of western and northern Canada, his winters in Ottawa writing reports on his geological and other findings. He enjoyed his field work especially (in one week in Alberta he discovered the largest deposit of prehistoric bones and the greatest deposit of workable coal to be found in Canada). He is probably best known scientifically for his postulation, based on rock striations, that during the Ice Age Canada was not covered by a single massive ice field which advanced and retired once on a long front, but by several glaciers which originated from separate centers and had advanced and retreated on several occasions. During his lifetime, besides his geological reports, he also wrote dozens of books and articles on such topics as Samuel Hearne, David Thompson, Canadian history, and mining in Canada.

In 1899 Tyrrell left the Survey because he had been denied promotion, and moved to the Klondike as a Mining Consultant. He lived there in the midst of the gold rush until 1905, learning so much about gold that the rest of his career was centered on this mineral, in part as a goldmine manager near Kirkland Lake, Ontario. When he retired a wealthy man, he turned to managing an apple orchard on the Rouge River, where many of us who lived in Toronto at the time were privileged to meet him. He died in 1957 at the age of 99.

This book is a timely one, dealing as it does with one of our first native-born natural scientists. It not only follows Tyrrell's life in detail, but it gives us a glimpse of the milieu in which an early government scientist worked (The Ottawa Field-Naturalists' Club meetings for example offered Tyrrell and his friends a welcome diversion from their work). We are indebted to Inglis for bringing the life of this remarkable Canadian to our attention.

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NEW TITLES

Zoology

Animal facts and feats. 1977. By Gerald L. Wood. Revised edition. Sterling, New York. 256 pp., illus. US $14.95.

Animals in peril. A guide to the endangered species of Canada and the United States. 1978. By David C. Grainger. Macmillan, Toronto. 192 pp., illus. $14.95

The beetles of North America. 1977. By Richard Headstrom. Barnes, Cranbury, New Jersey. 448 pp., illus. US $17.50.

The California quail. 1978. By A. S. Leopold. University of California Press, Berkeley. xx + 281 pp. US $14.95.

A changing world for wildlife. 1977. By G. S. Fichter. Golden/Western, New York. 141 pp., illus. US $8.95.

Coyotes: biology, behavior and management. 1978. Edited by M. Bekoff. Academic, New York. 400 pp. US $34.50.

†**Endangered birds.** Management techniques for preserving threatened species. 1978. Edited by Stanley A. Temple. University of Wisconsin Press, Madison. xxiii + 466 pp., illus. US $9.50.

†**L'entomologiste amateur.** 1977. Par A. Villiers. Savoir en histoire naturelle xxvii. Lechevalier, Paris. 248 pp. illus. 90F.

Great Canadian animal stories. 1978. Edited by Muriel

Whitaker. Hurtig, Edmonton. 232 pp., illus. $12.95.

*__Mammals of the palaearctic region: a taxonomic review.__ 1978. By G. B. Corbet. British Museum (Natural History). Cornell University Press, Ithaca. 314 pp., illus. US $38.50.

*__Nesting ecology of Canada geese in the Hudson Bay Lowlands of Ontario: evolution and population regulation.__ 1977. By Dennis G. Raveling and Harry G. Lumsden. Fish and Wildlife Report No. 98. Ontario Government Bookstore, Toronto. v + 77 pp. Paper $3.50.

__The response of peregrine falcons *(Falco peregrinus)* to aircraft and human disturbance.__ 1977. By Jim Windsor. Canadian Wildlife Service, Ottawa. 87 pp.

__The Running Press book of turtles.__ 1977. By Richard E. Nicholls. Running Press, Philadelphia. 150 pp., illus. Paper US $4.95.

__The view from the oak: the private worlds of other creatures.__ 1977. By Judith and Herbert Kohl. Sierra Club/Scribners, San Francisco. 112 pp., illus. Cloth US $8.95; paper US $4.95.

__Water birds of California.__ 1977. By H. L. Cogswell and G. Christman. University of California Press, Berkeley. 399 pp. Paper US $5.75.

__Wild birds of the Americas.__ 1977. By Terence Michael Shortt. Houghton Mifflin, Boston. 272 pp., illus. US $14.95.

Botany

†__Ferns of the Ottawa district.__ 1978. By William J. Cody. Agriculture Canada Publication 974. Supply and Services Canada, Hull. 112 pp., illus. $3.25 in Canada; $3.90 elsewhere.

__A field guide to edible wild plants of eastern and central North America.__ 1978. By L. Peterson. Houghton Mifflin, Boston. 384 pp. US $8.95.

__Grass: the everything, everywhere plant.__ 1977. By Augusta Goldin. Nelson, New York. 176 pp., illus. US $7.95.

__Mushrooms of North America.__ 1977. By O. K. Miller, Jr. Chanticleer/Dutton, New York. 368 pp., illus. Paper US $8.95.

†__Native trees and shrubs of Newfoundland and Labrador.__ 1978. By A. Glenn Ryan. Newfoundland Department of Tourism, St. John's. 117 pp., illus. Free.

†__North American forest lands at latitudes north of 60 degrees.__ 1978. By various authors. Proceedings of a symposium, University of Alaska, 19–22 September, 1977. School of Agriculture and Land Resources Management, University of Alaska, Fairbanks. 332 pp., illus. Free.

__Syrup trees.__ 1978. By Bruce Thompson. Walnut Press, Fountain Hills, Arizona. US $6.95.

__Wild food plants of Indiana and adjacent states.__ 1977. By Alan and Sue McPherson. Indiana University Press, Bloomington. viii + 215 pp., illus. Paper US $4.95; cloth US $12.50.

Environment

__Biological data in water pollution assessment: quantitative and statistical analyses.__ 1978. Edited by K. L. Dickson, John Cairns, Jr., and R. J. Livingston. Special Technical Publication 652. American Society for Testing and Materials, Philadelphia. 193 pp. US $17.50 (less 20% to ASTM members).

__Biological nomenclature.__ 1978. By C. Jeffrey. 2nd edition. Crame, Russak, New York. viii + 72 pp. US $11.50.

__The breakdown and restoration of ecosystems.__ 1978. Edited by M. W. Holdgate and M. J. Woodham. NATO Conference Series I: Ecology, Volume 3. Plenum, New York. 506 pp. US $36.

__Concepts of applied ecology.__ 1978. By R. S. DeSanto. Springer-Verlag, New York. 320 pp. Paper US $9.80.

†__Environmental role of nitrogen-fixing blue-green algae and asymbiotic bacteria.__ 1978. Edited by U. Granhall. Ecological Bulletins NFR 26. Swedish National Science Research Council, Stockholm. 400 pp., illus. 100SwCr.

__Estimating the hazard of chemical substances to aquatic life.__ 1978. Edited by John Cairns, Jr., K. L. Dickson, and A. W. Maki. American Society for Testing and Materials, Philadelphia. 283 pp. US $19.50 (less 20% to ASTM members).

__Evolutionary ecology.__ 1978. By E. R. Pianka. Harper and Row, New York. 384 pp. US $16.95.

__The green world: an introduction to plants and people.__ 1978. By Richard M. Klein. Harper and Row, New York. 512 pp. US $14.95.

__The management of estuarine resources in Canada.__ 1978. By Irving K. Fox and J. P. Nowlan. Report No. 6, Canadian Environmental Advisory Council, Ottawa. 51 pp. Free.

__Mexican wilderness and wildlife.__ 1978. By Ben Tinker. University of Texas Press, Austin. xii + 132 pp., illus. US $9.95.

__Reports of the first and second meetings of public interest groups with the Canadian Environmental Advisory Council.__ 1978. By anonymous. Report No. 7, Canadian Environmental Advisory Council, Ottawa. 124 pp. Free.

__Resources, environment and economics.__ 1978. By R. U. Ayres. Wiley-Interscience, Somerset, New Jersey. 240 pp. US $24.95.

__Sourcebook on the environment.__ A guide to the literature. 1978. Edited by K. A. Hammond, G. Macinko, and W. B. Fairchild. University of Chicago Press, Chicago. x + 614 pp. US $22.

__Water and society: conflicts in development.__ Part 1. The social and ecological effects of water development in developing countries. 1978. Edited by Carl Widstrand. Pergamon, New York. 134 pp., illus. US $20.

Miscellaneous

__Carbon dioxide, climate and society.__ 1978. Edited by Jill Williams. Proceedings of an IIASA Workshop, 21–24 February, 1978. Pergamon, New York. 304 pp. US $30.

__Earth observation systems for resource management and environmental control.__ 1978. Edited by Donald J. Clough and L. W. Morley. Plenum, New York. 475 pp. US $42.50.

Journey through the universe. An introduction to astronomy. 1978. By T. L. Swihart. Houghton Mifflin, Boston. xvi + 366 pp., illus. US $15.95.

The mountains of Canada. 1978. By Randy Morse. Hurtig, Edmonton. 144 pp., illus. $29.95.

Quaternary geology: a stratigraphic framework for multidisciplinary work. 1978. By D. Q. Bowen. Pergamon, New York. 224 pp., illus. Cloth US $30; paper US $12.50.

Manual on water. 1978. Edited by C. E. Hamilton. Special Technical Publication 442A. American Society for Testing and Materials, Philadephia. 471 pp. US $28.50 (less 20% to ASTM members).

Correction

The listings of "Zoology New Titles," Canadian Field-Naturalist 92(3): 316, 1978, should read as follows:

Biology of bats, volume 3. 1977. Edited by W. A. Wimsatt. Academic, New York. 651 pp., illus. US $59.

Biology of bryozoans. 1977. Edited by R. M. Woolacott and R. L. Zimmer. Academic, New York. 556 pp., illus. US $35.

†available for review
*assigned for review

Instructions to Contributors

Content

The Canadian Field-Naturalist is a medium for the publication of scientific papers by amateur and professional naturalists or field-biologists reporting observations and results of investigations in any field of natural history provided that they are original, significant, and relevant to Canada. All readers and other potential contributors are invited to submit for consideration their manuscripts meeting these criteria. As the journal has a flexible publication policy, items not covered in the traditional sections (Articles, Notes, Letters, News and Comment, and Book Reviews) can be given a special place provided they are judged suitable. Readers are encouraged to support regional, provincial, and local natural history publications as well by submitting to them their reports of more restricted significance.

Manuscripts

Please submit, in either English or French, three complete manuscripts written in the journal style. The research reported should be original. It is recommended that authors ask qualified persons to appraise the paper before it is submitted. Also authors are expected to have complied with all pertinent legislation regarding the study, disturbance, or collection of animals, plants, or minerals.

Type the manuscript on standard-size paper, if possible use paper with numbered lines, double-space throughout, leave generous margins to allow for copy marking, and number each page. For Articles, provide a running head, a bibliographic strip, an abstract, and a list of key words. These items are optional for Notes. Generally words should not be abbreviated but use SI symbols for units of measure. Underline only words meant to appear in italics. The names of authors of scientific names should be omitted except in taxonomic manuscripts or other papers involving nomenclatural problems. Authors are encouraged to use "proper" common names (with initial letters capitalized) as long as each species is identified by its scientific name once.

Although we prefer the names of journals in the Literature Cited to be written out in full, these may be abbreviated following the **Bibliographic Guide For Editors & Authors**, The American Chemical Society, Washington, D.C. (1974). Unpublished reports should not be cited here. Next list the captions for figures (numbered in arabic numerals and typed together on a separate page) and present the tables (each titled, numbered consecutively in arabic numerals, and placed on a separate page). Mark in the margin of the text the places for the figures and tables.

Extensive tabular or other supplementary material not essential to the text, typed neatly and headed by the title of the paper and the author's name and address, should be submitted in duplicate on letter-size paper for the Editor to place in the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository.

The **Council of Biology Editors Style Manual**, 4th edition (1978) available from the American Institute of Biological Sciences, is recommended as a guide to contributors. **Webster's New International Dictionary** and le **Grand Larousse Encyclopédique** are the authorities for spelling.

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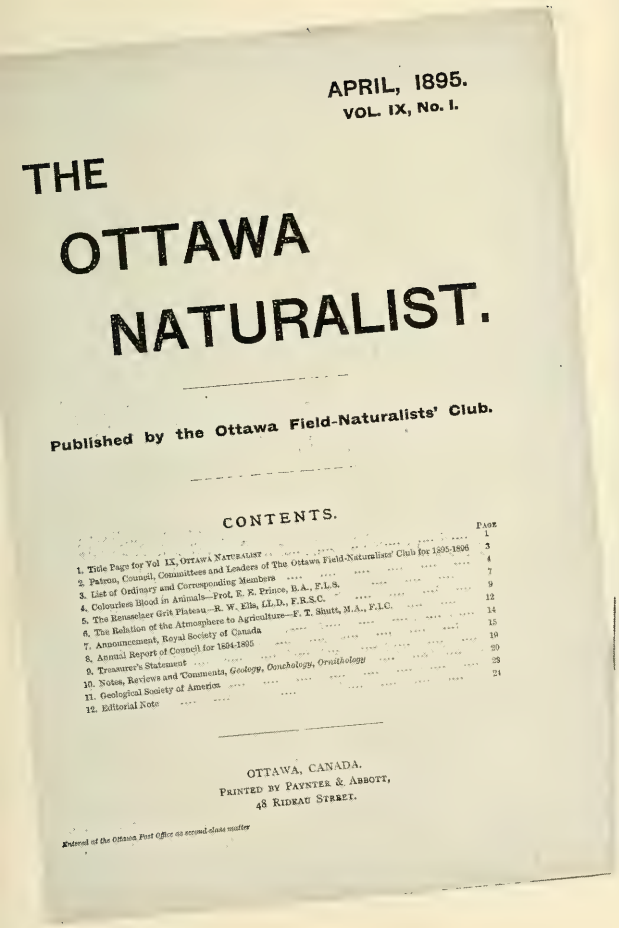

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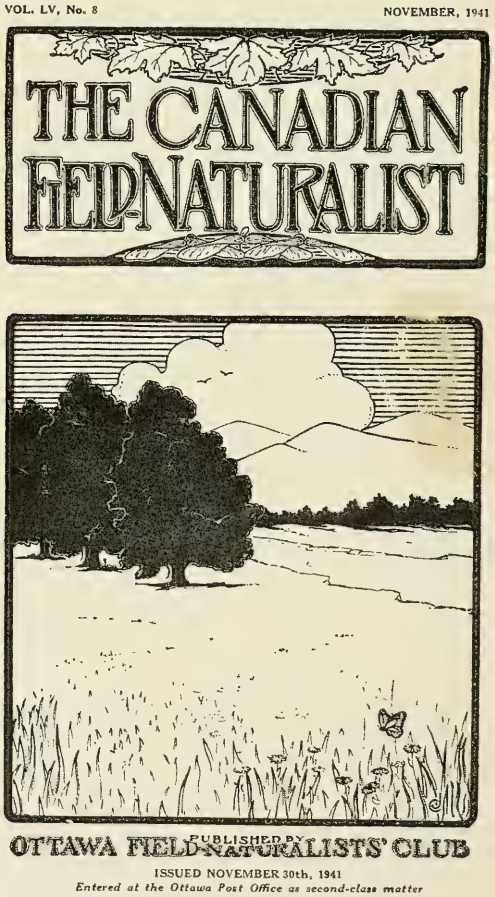

Centennial Year

Volume 93, Number 2

April-June 1979

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

The objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and cooperate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

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Cover: Since The Ottawa Field-Naturalists' Club was founded in 1879, it has published a scientific journal. Two covers are illustrated. Left, *The Ottawa Naturalist*, published from 1887 to 1919. Right, *The Canadian Field-Naturalist*, published from 1919 to the present; it bore this cover design from 1919 to 1944.

The Canadian Field-Naturalist

Volume 93, Number 2 April-June 1979

Our Responsibilities as Field-Naturalists and Biologists

The important message in the guest editorial by Yorke Edwards (Biology — the unknown science? Canadian Field-Naturalist 93(1): 6–9, 1979) is that the world needs more generalists in science and that workers in biology must communicate better. My comments here are offered not only as a reinforcement of his views but also to point out the responsibilities of field-naturalists and biologists regarding the quality, accuracy, and comprehensiveness of their studies.

Although for years biologists have been isolated from social and political changes, increasing dialogue between scientists and the general public and governments is taking place. Not all of this is productive. Nevertheless society is becoming more aware that many of the world's troubles are concerned with changes in normal biological processes and ecosystems and that the nature of environmental problems is complex. In order to formulate policies, decision-makers (normally situated at the government level) must assess the opinions, often conflicting ones, of scientists. Many scientists find it difficult to interpret science to the layman. Moreover, with increasing specialization some scientists can convey information only on limited topics in their own field of interest and are often unable to comprehend the total picture. Therefore, we need more competent generalists to integrate and interpret scientific data and to communicate science to society. As Yorke Edwards wrote, "We need a new morality in the sciences, resulting in major efforts to make science and its influence on Earth understandable."

Because the role of scientists in society is becoming more visible, I think it is germane to point out some of the responsibilities that we should be aware of, but often are not. In particular we should recognize our limitations, strive for accuracy, and maintain credibility.

It is important, however, not only that we recognize our own scientific limitations but that we do not exceed them. Unfortunately some biologists extend their studies, interpretations, and conclusions beyond their level of expertise and competence. Sometimes their conclusions are based on results obtained using faulty methods and are thus incorrectly attributed to environmental variation. Sometimes their opinions, whether right or wrong, have been accepted as facts. How does the decision-maker know whose opinion to respect? This is a major problem which has become even more complicated by the mushrooming number of biological consulting firms, some excellent but others abysmally bad. How often has the perhaps glossy, long-winded, eye-appealing final report of the contractor been valued rather than whether the work on which it is based was scientifically sound? How often will firms or individuals take on work that is beyond their qualifications? We know that some environmental consulting firms at least try to make up for their deficiencies in qualified and competent staff by contacting and "picking the brains" of acknowledged experts (often without any financial or other compensation or acknowledgment to the experts for their time and knowledge) whereas others make no attempt to improve the quality of their studies. Some contractors do not have the ability or inclination to do a proper literature search whereas others may do a search, then write a research paper under the pretence that their report contains original work.

Biologists or field-naturalists should not be considered specialists outside their own specialty. Environmental problems in particular are very complex, and what may appear on the surface to be simple almost always has complicated interrelated ecological aspects. The tendency to look at one particular aspect of a specific problem without regard for the broader view has sometimes resulted in

disastrous decisions. It is imperative, therefore, that the total involved system be considered if wise decisions are to be made. But so often this doesn't happen. Too few are able to see, let alone comprehend, the total aspect of biological problems and the complicated interrelationships that exist in nature. Generalists who approach interdisciplinary studies with open eyes and an open mind are needed to understand and to interpret the basic workings of complex ecosystems, i.e., to put it all together. But they too must know their limitations: they cannot be masters of all disciplines; therefore, they will need to consult specialists on specific aspects of particular problems. Although the popular interdisciplinary method of teamwork is commendable, often it does not fill the need for a broad approach. D. B. O. Savile pointed out some years ago (Unity from diversity in biological research. Transactions of the Royal Society of Canada 4(4): 245–251, 1966) that often each team member sees only his or her aspect of the problem. He elaborated further as follows: "For the clearest and fullest picture of any biological phenomenon, it is helpful if the interdisciplinary approach of the team is complemented by the multidisciplinary approach of the individual."

We have a responsibility to strive for accuracy. Sometimes incorrect descriptions, identifications, computations, etc., appear in reports. It is easier to perpetuate an error than to correct one. Studies should be carried out as thoroughly and competently as possible with careful regard to repeatability, the basis of the scientific method. Moreover, if statements can be misinterpreted, are ambiguous, or are otherwise unclear, they should be rewritten.

Often there is considerable pressure to do a study and to prepare the report quickly without particular regard for accuracy and dependability, and consequently too much may be read from limited data. Researchers should be obliged to state the limitations of their methods, data, and conclusions so that there will be less distrust and fewer set-backs but rather an advancement of knowledge.

We must endeavor to maintain our credibility and should encourage other biologists and field-naturalists to do so too. This is particularly important when the problems and issues that arise are emotional ones. Interpretations, recommendations, and conclusions should, as far as possible, be based on good sound scientific data. Speculation should be limited to what can be reasonably well supported. We mustn't compare apples and oranges. Thus the results obtained on one species cannot be directly extrapolated to another species.

Our credibility is dependent on the accuracy of our statements, on recognizing the limitations of the data, and on the limitations of our expertise. Obviously if errors are discovered in one part of our work, the results from an entire study will be suspect. For example at a recent naturalists' meeting, a petition for signatures was presented. Although this petition had an admirable conservation measure as an objective (it was against the legalization of the taking of certain birds of prey), alas the reasoning accompanying it was false. It was alleged that these particular raptors should be saved because as rodent-eaters they are beneficial to farmers. When it was pointed out that these particular birds prey mainly on birds, not rodents, the petition was not withdrawn for this error to be corrected. In such cases, where we make false statements, opponents will dwell on them, and a good cause may be lost.

A rather copious volume of "gray" scientific "literature" or pseudoliterature has appeared in recent years. Some of this has resulted from the many contracts let for baseline surveys and preparation of environmental impact statements. The greatest shortcoming of the duly written final reports is that they are not generally subjected to peer review as are research papers published in the primary literature. Frequently errors of commission and omission are put into such records and are perpetuated. Considerable time and effort are required to correct these. Indeed some are never corrected. The solution to this problem is not easy. Because they are not subjected to rigorous (or any in some cases) peer review, there is a tremendous variability in the reports in the gray literature: some reports are very superficial but others are excellent in-depth studies. Better evaluation of these reports is needed.

Floral and faunal surveys of many areas, especially national and provincial parks and areas designated by the International Biological Programme, are indeed valuable. But how can a judgment be made on whether the contractors are really trained and reliable? One partial answer is

to be sure voucher specimens are kept, because these at least can be checked for correct identification. We know of at least one government contract where the employees of a consulting firm had misidentified and reported incorrectly on a large proportion of the specimens. It is cases like this that when discovered cause credibility to be lost. But how many go undetected? Many biologists and field-naturalists are concerned about these quick and superficial surveys, with the overconfidence of some investigators, and in the final analysis with credibility.

Other scientists are also worried about these problems. In his editorial in the first issue of a new journal *Marine Environmental Research* (July 1978) Eric Cowell wrote: "Nowhere has departure from scientific integrity been more evident than in the field of environmental research. . . . There is much to learn about the function of our ecosystem and man's role in the management or mismanagement of it. We need clearly defined objectives, impeccable data and analyses and interpretation conducted with integrity."

My plea to field-naturalists and biologists is to follow the old adage "if it's worth doing, it is worth doing well." Of course it takes time and effort to do good research, whether it is in the field, in the laboratory or museum, or in the library. Check for accuracy, maintain scientific integrity, exercise care in the interpretation of data, and recognize the limitations. Seek the comments of specialist colleagues but look to generalists to give the total picture. Only if we recognize and carry out these responsibilities can we hope to maintain quality and standards and to contribute positively to society as responsible citizens.

LORRAINE C. SMITH
Editor

Natural Fires as an Index of Paleoclimate

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Terasmae J. and N. C. Weeks. 1979. Natural fires as an index of paleoclimate. Canadian Field-Naturalist 93(2): 116–125.

The charcoal abundance and frequency of occurrence varies stratigraphically in postglacial lake sediments, and this information can be used together with palynological and sedimentological data for a reconstruction of paleoclimatic conditions. The gelatin-coated slides method can be used for continuous sampling of lake sediment cores to determine the presence of charcoal particles. Changes in the charcoal profile have been related to changes in the sequence of fossil pollen, specifically that of pine pollen, and from the observed relationship a climatic control of forest fires is inferred. Forest fires have occurred naturally in the Great Lakes – St. Lawrence and Boreal forest regions during the past 9000 yr, and the fire frequency almost doubled during the Pine Pollen Zone about 7000 to 4000 yr ago in the southern Boreal forest. The mean fire frequency in the Lac Louis area was one fire every 95 to 100 yr, but during the period characterized by a pine pollen maximum, 7280 ± 240 yr BP (GSC-1481) to 4260 ± 240 yr BP (GSC-1491), the fire frequency increased to one fire every 48 to 56 yr.

Key Words: forest fires, palynology, paleolimnology, paleoclimate.

Natural fires, as distinct from man-induced ones, have been characteristic of terrestrial ecosystems probably for many millions of years. The prerequisites are (1) a readily combustible 'fuel' source (vegetation) and (2) an igniting mechanism. The first of these is satisfied whenever and wherever a supply of dry vegetation is available, and both lightning and volcanism have been present as igniting mechanisms throughout geological time; however, the frequency of coincident fuel, ignition, and fire has varied through time.

The fact that numerous and very extensive forest fires, as well as grassland and also tundra fires, coincide with general or seasonal dry weather episodes (drought) appears to be commonly accepted (Rowe et al. 1974, 1975). Meteorological conditions leading to such episodes of drought are caused by lack of precipitation, relatively high summer temperature, extended periods of sunny weather, and medium- to high-velocity surface wind. A combination of these meteorological variables will intensify the development of drought conditions and, hence, increase the susceptibility of vegetation to fire. The linkage between climatic conditions and the frequency and areal extent of natural fires in vegetation seems to be well established. Therefore we assume that if the frequency of natural fires can be determined by studies of sediment records preserved in lakes and peat bogs, it will be possible to interpret this information in terms of past climatic conditions and to use the time frequency of natural fires as an indicator or index of paleoclimate.

There has been also an increasing interest in the place of natural fire in the environment over the past few years, paralleled by a growing perception of fire as a natural and necessary environmental factor rather than an unnatural "disturbance" that must be controlled and eliminated whenever and wherever possible.

The presence of charcoal fragments is the primary evidence that natural fires leave in the sedimentary record, as indicated already by other studies (e.g., Heinselman 1971, 1973; Swain 1973; Rowe and Scotter 1973).

The purpose of this study is to investigate the methods used for extracting fire frequency records from lake sediments, and the criteria for selecting appropriate sites for this kind of study.

Lake sediments constitute a natural depository of environmental information that accumulates year by year throughout the life-span of a lake. These sediments contain inorganic (sand, silt, clay) particles and organic detritus (pollen, spores, diatoms, cladocera, various other algae and fungi, identifiable plant tissue fragments, and charcoal), as well as chemical residues, precipitates, break-down products, and stable compounds. All these components collectively

reflect the environmental conditions within the lake as well as in the surrounding area. A stratigraphic study of these sediment components can establish a time series of ecological events from which paleoecological and environmental changes can be inferred on the basis of modern analogues (studies of recent limnological-environmental relationships).

The study was designed to (1) explore the stratigraphic occurrence of charcoal in sediments of selected lakes for the purpose of establishing a charcoal frequency record for postglacial (Holocene) time, (2) infer from this record the frequency of natural fires (forest fires), and (3) relate this information to the paleoenvironmental changes (including climate and vegetation) that have been established for the same time interval on the basis of palynological studies of the same sediment cores.

It was assumed that charcoal particles, originating from forest fires, are transported to the lake by atmospheric turbulence (wind), possibly by surface water runoff, and direct falling of charred plant matter into the lake. Charcoal influx, contributed by all means of transport, would be further dispersed in the lake by surface currents and eventually settles to the bottom where it is incorporated in the accumulating sediment as an identifiable record of the fire.

Location and Description of the Study Sites

The study sites were four lakes (Figure 1) selected because of availability of background, palynological studies, radiocarbon dating, mapping of surficial deposits, and the knowledge of postglacial history of the region. Furthermore, palynological studies of lake sediments and peat deposits made at numerous sites throughout Ontario by the senior author over a period of some 20 years (Terasmae 1973) had demonstrated common occurrence of charcoal particles in many palynological preparations. There seemed to be an apparent lack of published information from southern Ontario on charcoal occurrence in lake sediments and its relationship to the postglacial history of natural fires.

Three lakes are in the Great Lakes – St. Lawrence Forest region (Found Lake, 45°30′65″N, 78°30′80″W; Perch Lake, 46°02′N, 77°21′W; and Boulter Lake, 46°09′15″N, 79°02′W) whereas Lac Louis (47°15′15″N, 79°07′W) is in the southern part of the Boreal Forest region. The Great Lakes – St. Lawrence Forest is characterized by a mixture of deciduous hardwood tree species and some coniferous tree species, but coniferous tree species attain dominance in the Boreal Forest (Rowe 1959). Some descriptive data on the four lakes and their sediments are summarized in Table 1.

All four lakes are different in terms of their geological characteristics. Found Lake is a bedrock basin, surrounded by steep rock slopes, and characterized by only minor inflow of surface and ground water. It is oligotrophic and has a low sedimentation rate (0.41 mm per year). Perch Lake is a depression in surficial deposits (mostly sand) and only a minor part of the shore is bordered by bedrock. It receives some groundwater and surface-water inflow through surrounding swamp and bog vegetation that filters out particulate matter, and a small creek flows out of Perch Lake to Ottawa River. It is about 8–10 km from the large sand dune area of the Petawawa delta. The lake is eutrophic and has an average sedimentation rate of 0.61 mm per year.

Boulter Lake occupies an ice block depression (a "kettle hole") in glacial outwash and esker deposits. It has no bedrock shoreline and probably receives some inflow of groundwater. There are no streams flowing into or out of the lake, and it is eutrophic; average sedimentation rate is 0.66 mm per year.

Lac Louis (elevation 300 m) is located just below the highest shoreline (305 m) of glacial Lake Barlow-Ojibway in a sand and gravel deposit of an esker complex (Vincent 1973), and it is probably a "kettle" lake. It receives some inflow of groundwater and a small stream flows out of it. It is surrounded by Black Spruce (*Picea mariana*) forest and muskeg, with some Trembling Aspen (*Populus tremuloides*) and White Birch (*Betula papyrifera*). The lake is eutrophic; average sedimentation rate is 0.59 mm per year.

The lakes share a common characteristic, being essentially closed basins, without any major inflowing streams and with only minor outflow. Furthermore, all lakes are surrounded (except where bedrock forms the shore) by wetland vegetation (bog and swamp) that effectively prevents input of particulate matter by

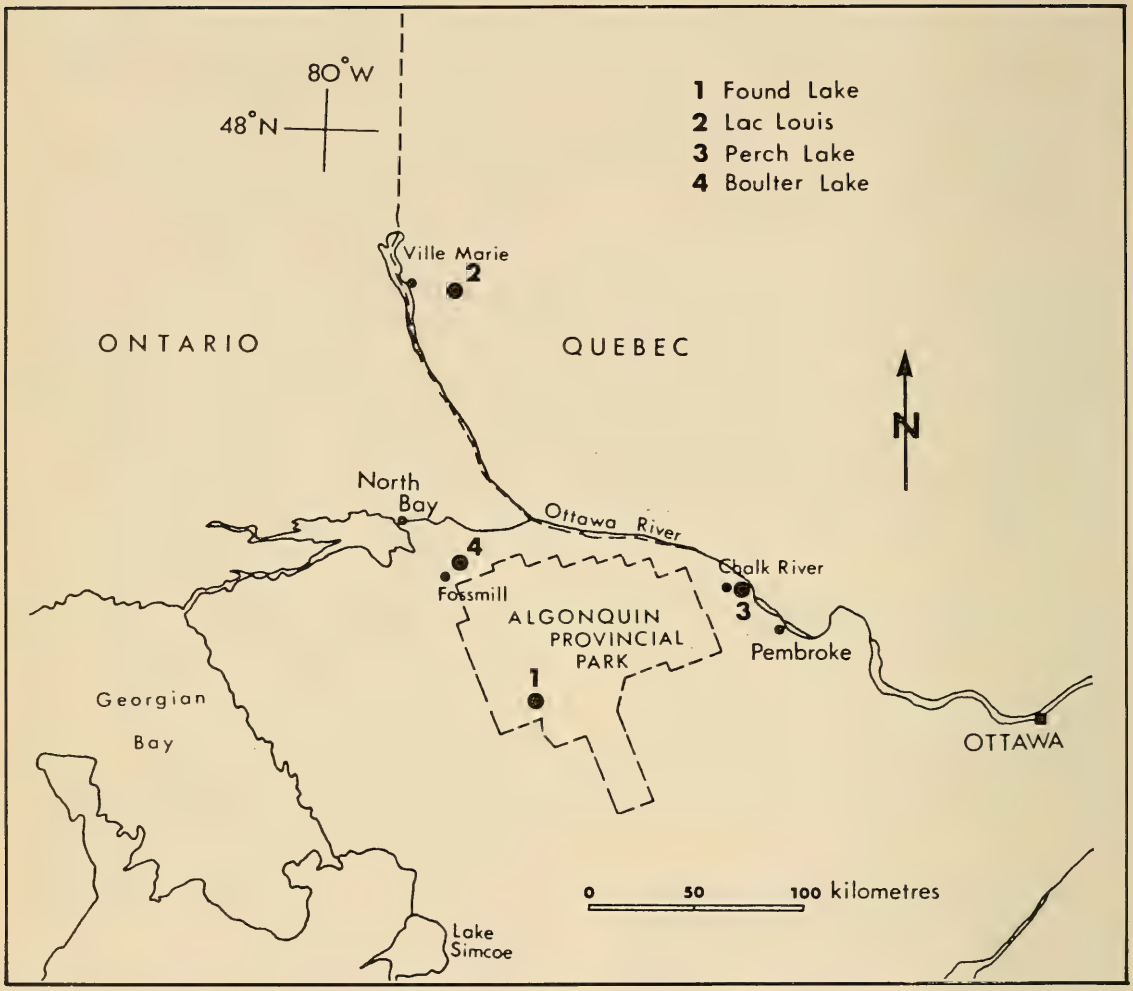

FIGURE 1. Index map, showing the location of study sites. Found Lake (site 1), Perch Lake (site 3), and Boulter Lake (site 4) are in the Great Lakes – St. Lawrence forest region, and Lac Louis (site 2) is in the southern part of the Boreal forest region.

TABLE 1—Some measurements and comparative data on the four lakes studies

	Found Lake	Perch Lake	Boulter Lake	Lac Louis
Elevation (m)	460	156	389	300
Maximum depth of water (m)	34	3.5	8.5	7.6
Thickness of organic sediment cored (cm)	430	600	780	540
Surface area (km^2)	0.32	0.45	0.25	0.10
Age of oldest organic sediment (years BP)	10400 ± 300 (I-7782)	9830 ± 250 (GSC-1516)	11800 ± 400 (GSC-1363)	9090 ± 240 (GSC-1432)
Average sedimentation rate (mm per year)	0.41	0.61	0.66	0.59

surface water runoff. It is assumed, therefore, that charcoal particles found in the lake sediment have been transported to the lakes primarily by atmospheric dispersal. The only exception would be charcoal input by water runoff from the small area of bedrock slopes adjacent to the lake. This assumption is supported by the observation that many charcoal particles in the lake sediment are in the same size range as pollen (about 20 to 150 μm) that is transported to the lakes by atmospheric dispersal. All four lakes are also characterized by very small watersheds, effectively restricted to the surrounding slopes extending only 100–200 m away from the lake. Only Perch Lake has a larger catchment area that is occupied by wetland vegetation.

Methods

The lake sediment cores were taken with piston corers; the Brown sampler was used for very soft sediment at and near the water-sediment interface, and the Livingstone sampler for the remainder of the organic and inorganic sediments cored (Mott 1966), after a reconnaissance of lake basin morphometry (depth sounding) and the surrounding landscape had been made. Palynological subsampling of sediment cores, laboratory preparations, and microscopic examination of slides followed well established procedures (Faegri and Iversen 1975; Kummel and Raup 1965).

The study of charcoal presence and abundance was carried out in two different ways. In one case the palynological slides were used for counting of charcoal particles. The principal problem in this case is that samples for a palynological study (0.5 to 1 cm^3) are normally taken at 10-cm (or sometimes 5-cm) intervals from the sediment core, and each sample covers sediment deposition during 10–20 yr, depending on sedimentation rate. This method of sampling obviously does not provide any information for the time intervals (about 100–200 yr) represented by sediment deposition between the sampled intervals; therefore, it is possible that a significant part of the record of forest fires may be missed.

To overcome this problem in the charcoal study, Weeks developed another preparation method, based on a technique used for sedimentary grain-size analysis by Perrie and Peach (1973) and Peach and Perrie (1975). The method involves two principal steps: preparation of gelatin-coated slides, and transfer of sediment onto the slide.

The slides were prepared by first dissolving 1.5 teaspoons "Knox Gelatin" in 300 mL distilled water (the water-gelatin mixture was warmed in a water bath). Clean glass slides were then dipped in the gelatin coating solution (except the frosted ends, used for labelling). The excess gelatin was allowed to run off the slides, which were then placed in a dust-free cabinet to dry for a maximum of 6 h before storage in a clean slide box.

The second step began with preparation of the sediment core for sampling. The sediment surface was carefully scraped clean of possible contamination with a spatula, and this surface was made smooth so that the full gelatin-coated area of the sampling slide came into contact with the sediment when the slide was touched or pressed against the core.

It should be noted that the sediment cores, after they had been extruded from the coring tubes, were wrapped in plastic and aluminum foil and stored in a temperature-controlled room at 3–5° C to retain the natural moisture content, a normal practice for palynological studies.

The sampling was carried out by pressing the gelatin-coated slide lightly to the sediment core; a thin layer of moist sediment sticks to the dry gelatin surface and a "fingerprint" of particles is lifted off. The amount of pressure on the slide, required for producing a good "fingerprint," depends on sediment characteristics and moisture content and this is determined experimentally by examining the slides under a microscope to make sure that the optimum amount of sediment is picked up by the slide. Too much sediment on the slide makes counting of charcoal particles difficult; too little sediment requires the counting of these particles on several slides, which is rather time-consuming. It is expected that further experimentation will lead to a more specific description of this aspect of the method. This sampling method covers the total length of the core without any gaps between samples.

Cover slips were placed on the slides and a small amount of xylene was added to the edge of

the cover slip. The xylene dispersed throughout the preparation and rendered most of the organic detritus matrix translucent, whereas charcoal particles, pollen grains, and diatoms remained clearly visible. The 'clearing effect' of xylene made the identification and counting of charcoal particles much easier (Figure 2).

Charcoal particles were identified with the aid of samples collected from sites of recent forest fires and prepared according to methods used in this study. Normally these particles are readily identifiable because some larger (commonly wood) fragments are only partially charred and others still retain characteristics of recognizable plant tissue structure. Some smaller charcoal particles are opaque (black) and differ from mineral grains with respect to fracture, refractive index, and surface characteristics. The common mineral grains are, furthermore, mostly transparent and lack cellular structure. The problem of small pyrite grains that occur in some lake sediments (even inside of pollen grains), however, requires further investigation.

The charcoal particles were counted in three different ways. In the first case, charcoal was counted together with pollen on slides prepared for palynological study. This technique provides a direct comparison of charcoal abundance with palynological data in the same preparation.

In the second case the charcoal particles were counted on the gelatin-coated slides. The purpose of this technique was to relate charcoal abundance to sediment stratigraphy because each slide covers about 5 cm of sediment deposition.

In the third case, an attempt was made to use the Quantimet 720 (a TV image-analyzing computer) for counting of charcoal particles on the gelatin-coated slides. The advantage of this technique is that the instrument can be set to count particles in predetermined size classes, as described by Peach and Perrie (1975) in their study of varved glacial lake sediments. There was some difficulty, however, in having the Quantimet distinguish charcoal particles from other similar particles, and further experiments will have to be made to resolve this problem.

For sediment cores from Lac Louis, Found Lake, and Boulter Lake the charcoal occurrence and relative abundance were tabulated on the basis of data obtained from continuous sampling by the gelatin-coated slides method. For Perch Lake the charcoal data were obtained by examination of the palynological slides and palynological data were adopted from available pollen diagrams (Boyko-Diakonow and Terasmae 1975). The charcoal data for the three other lakes (Lac Louis, Boulter Lake, and Found Lake) were obtained from the same sediment cores that had been used for palynological study (Vincent 1973; R. J. Mott, personal communication; M. Boyko-Diakonow, personal communication), and a direct comparison of both kinds of data was again possible.

In Figure 3 the abundance of charcoal was calculated in the same manner as the relative pollen percentages of the different tree species; i.e., the total number of pine pollen grains, for example, is expressed in the pollen diagram as a percentage of the total tree pollen count in a particular preparation (sample).

The determination of sedimentation rate was considered an important aspect of the study of stratigraphic dispersal of charcoal in lacustrine deposits because the estimated (or assumed) sedimentation rate provides the time scale for chronostratigraphy of charcoal occurrence and abundance, unless some other means of time calibration is available (for example, when the sediment is annually laminated, or varved). Radiocarbon dates were available for all sediment cores studied and these dates were used to calculate the approximate sedimentation rates that are shown in Table 1 for each of the lakes investigated.

All tabulated data used as the basis of this paper are included in an unpublished report by Weeks (B.Sc. thesis, available from Department of Biological Sciences, Brock University).

Results and Discussion

Our observations indicate that charcoal does not occur in distinct layers with well defined boundaries in the lake sediments studied. Although the abundance of charcoal particles changes stratigraphically, the boundaries of each occurrence of these particles are diffuse, implying that at least some mixing of sediment has taken place during deposition and that charcoal dispersal (in decreasing amounts) may have occurred during several years after the fires that are recorded in the lake sediment.

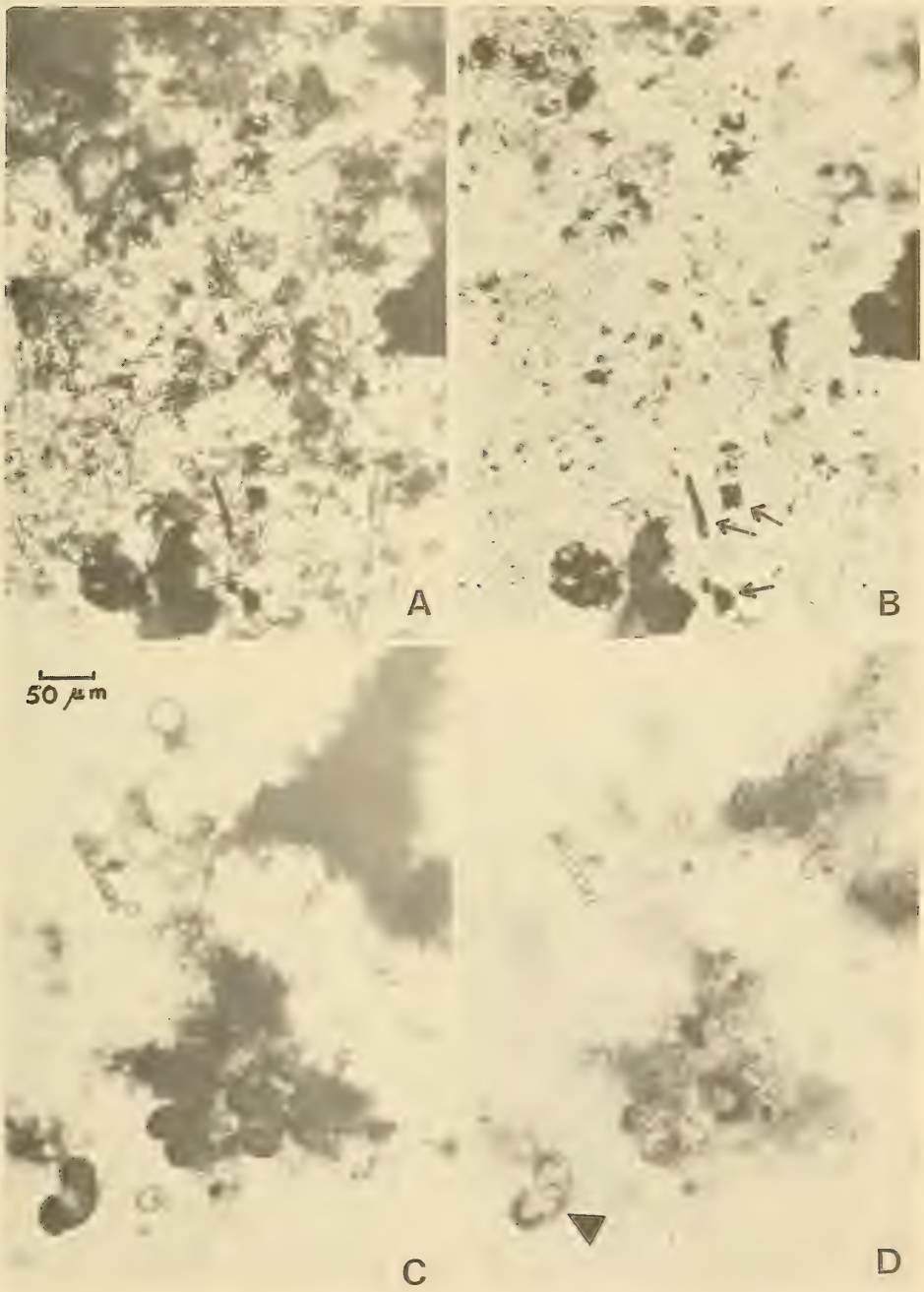

FIGURE 2. Photomicrographs of gelatin-coated slides from Boulter Lake sediment core: (A) untreated, (B) the same slide after clearing with xylene; and Found Lake: (C) untreated, (D) cleared with xylene. Arrows — charcoal particles; black triangle — pine pollen grain.

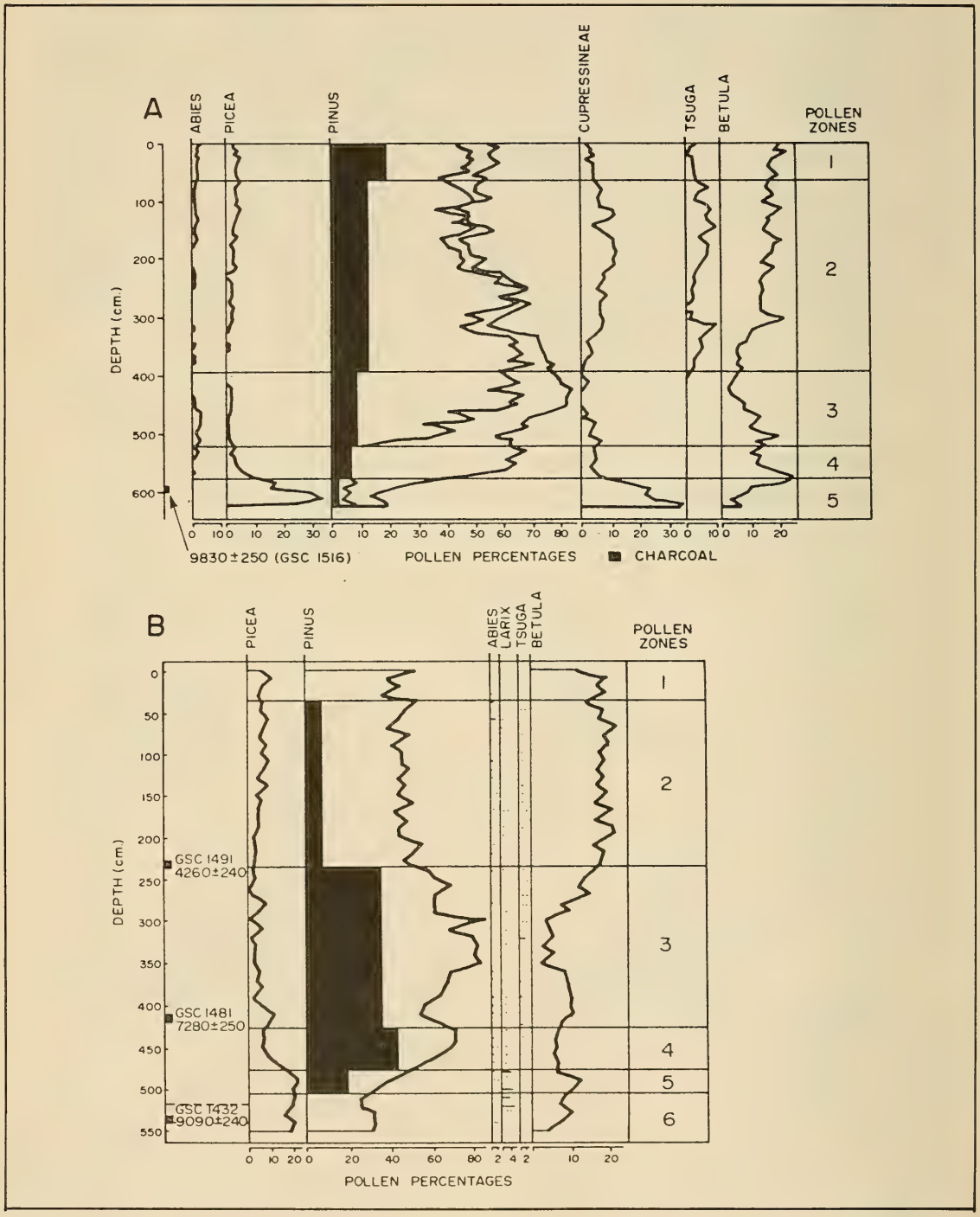

FIGURE 3. Abbreviated pollen diagrams from Perch Lake (A) and Lac Louis (B). The black areas indicate occurrence and abundance of charcoal particles, based on study of palynological slides (Perch Lake) and gelatin-coated slides (continuous sampling) from the Lac Louis sediment core.

The diffuse nature of the charcoal layers in lake sediments has not been explained adequately by this study and the subject of modern charcoal dispersal and deposition in lakes requires more investigation.

In the Perch Lake study all palynological slides contained some charcoal, but in view of the large sampling interval (about 10 cm) as compared with the annual sedimentation rate (0.61 mm) it is not possible to be certain of the actual stratigraphic frequency of charcoal occurrences. Quite certainly many charcoal occurrences are not recorded by this type of study and the question of how much information was missed in the Perch Lake study will be investigated further.

The Found Lake sediment core contained relatively little charcoal, both in terms of stratigraphic occurrence and abundance. On the other hand, the part of Boulter Lake sediment core (640–750 cm) that was examined in this study (because palynological data were available only for the basal 2 m of this core) contained abundant charcoal at frequent intervals.

The Lac Louis sediment core showed a rather high frequency of charcoal occurrence with a non-uniform stratigraphic distribution and varying abundance. A pollen diagram for Lac Louis has been published by Vincent (1973).

The sparseness of charcoal in the Found Lake sediment core can be attributed to at least two possible causes. One is the site susceptibility to fire, because the forest of the Found Lake area is dominated by hardwoods, mainly maple (*Acer*), beech (*Fagus*), and birch (*Betula*). The second is related to the seasonal frequency distribution of thunderstorm activity. According to Chapman (1952) some thunderstorms in this area coincide with the period of fire susceptibility in the hardwood forest, but the greatest thunderstorm activity occurs in June, July, and August when the trees are in full leaf. Autumn fire hazard is reduced by the increased precipitation during that season, and Chapman refers to this northern hardwood forest as being the most nearly immune to fire of all forest types.

These two causes may explain the paucity of charcoal in the Found Lake sediments during the last 7000 to 8000 yr but this reasoning becomes much weaker for the earlier postglacial time, when, on the basis of palynological evidence, the forest in this area contained more pine and fewer hardwood species some 8000 to 10 000 yr ago, and the forest was dominated by spruce prior to 10 000 yr ago. Therefore, it is unlikely that vegetation alone was the factor in fire resistance in early postglacial time, although it may be now. Probably other factors, including topography, microrelief, and soil moisture are also important, and Found Lake may not be a good site for carrying out forest fire frequency studies.

Charcoal particles were present throughout the Lac Louis sediment core, and the charcoal profile as shown in Figure 3 was based on the continuous sampling procedure, using gelatin-coated slides. Unfortunately the top and bottom ½ m of sediment core was not available for this study, and hence no charcoal profile is shown for these parts of the core in Figure 3.

Interpolation of the radiocarbon dates for Lac Louis (reported by Vincent 1973) gives an age of about 8100 yr BP at the 480-cm depth of sediment. Within the 480 cm, there are 84 charcoal occurrences. If we assume that each is related to a separate fire event, there is one fire every 95 to 100 yr. This is probably an inaccurate estimate, however, because the distribution of charcoal is stratigraphically non-uniform, and a simple expression of mean frequency fails to express the fluctuations of fire frequency throughout the sediment core. For example, fire frequency in the pine zone (Pollen Zones 3 and 4) of the Lac Louis sediment core (Figure 3) is one fire every 48 to 56 yr — at least double the mean fire frequency for the whole core.

Although only a part of the Boulter Lake sediment core was examined for charcoal (640–750 cm), this part of the core contains the pine pollen zone (R. J. Mott, personal communication) and both a high frequency and abundance of charcoal. It seems that in Lac Louis, and probably in Boulter Lake, the high frequency and abundance of charcoal coincides with high percentages of pine pollen (the Pine Pollen Zone).

For Perch Lake, the fire frequency, based on examination of pollen slides, is calculated to be one fire every 140 to 150 yr. This is a much lower fire frequency than one would expect, given the long history of fire which is evident from palynological data and an environment char-

acterized by sand dunes of the Petawawa delta and pine-dominated vegetation. This value also conflicts with the findings of Cwynar (1975) at a similar site, about 50 km to the west where the mean fire frequency in Greenleaf Lake area over the past 1200 yr is one fire every 83 yr. It seems reasonable to conclude that a number of charcoal occurrences have been missed owing to the distance between 10-cm sampling intervals.

A study of Lake of the Clouds, Minnesota, relates forest vegetation succession over the past 10 000 yr to climatic change, and charcoal data to the changes in forest vegetation (Swain 1973). Swain reports an increase in fire frequency after 9500 yr BP, which coincides with a pine pollen peak and a climatic warming trend (the hypsithermal) which reached an optimum about 7000–6000 yr BP. Consistent high charcoal abundance occurred from 9000 to 6000 yr BP. Then a period of climatic cooling began, spruce and alder increased, White Pine (*Pinus strobus*) decreased, and charcoal abundance became irregular from 6000 to 3000 yr BP. From 3000 to 1200 yr BP, a decrease in charcoal occurrence is associated with a similar decline in White Pine. The similarity between the pattern of climate, vegetation, and fire occurrence described by Swain at Lake of the Clouds and that reported by Vincent (1973) and this study at Lac Louis is rather striking. The same stratigraphic pattern of charcoal distribution seems to occur at both sites, but the Lac Louis dates are somewhat younger, possibly because of the difference in the time of deglaciation. The Lake of the Clouds area was deglaciated about 14 500 yr BP, but Lac Louis did not become ice free until about 10 500 yr ago. This implies that vegetation migrated northward with the receding ice and, therefore, radiocarbon dates from Lac Louis are about 7280 ± 240 yr BP (GSC–1481) for the beginning of Pollen Zone 3 and 4260 ± 240 yr BP (GSC–1491) for the end of this zone (the Pine Pollen Zone), compared to 9000 and 6000 yr BP for the Minnesota site.

Both Lac Louis and Lake of the Clouds lie within the Great Lakes – St. Lawrence and Boreal Forest transition zone. There seems to be good potential for paleoclimatic reconstruction on the basis of charcoal occurrence in, and pollen analysis of lake sediment cores within, this zone. The gelatin-coated slide technique for charcoal analysis could be useful in such regional paleoclimatic studies.

The results of the present study suggest that it will be possible to work out a postglacial forest fire frequency sequence for at least some regions, such as the deciduous forest and the boreal forest when study sites are selected with appropriate care. Geological site characteristics (topography, types of rocks and surficial deposits, surface and ground water regime, glacial history and landscape features such as deltas, outwash plains, eskers, etc.) should be considered with respect to fire susceptibility of the vegetation that grows on these different sites. For example, the Found Lake area seems to be rather resistant to forest fires: the Perch Lake area, in contrast, appears to have been especially susceptible to forest fires because of geological characteristics of the landscape that at least locally control the composition of forest. Therefore, these areas are less suitable for forest fire frequency studies than the Lac Louis area, or the Lake of the Clouds area in Minnesota.

It appears possible that a fire frequency index can be worked out for Holocene lake sediment sequences and related to paleoclimatic conditions that have been inferred, in part, from other kinds of evidence such as palynology and the physical and chemical sediment characteristics.

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Virgin Douglas Fir Forest on Saturna Island, British Columbia

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A survey of the Saturna Island Ecological Reserve provided a description of its virgin Douglas Fir (*Pseudotsuga menziesii*) forest. The vegetation was quantitatively analyzed with respect to structure and composition. The tree stratum dominated the structure of this reserve, followed secondarily by the low-shrub and bryophyte strata. *Pseudotsuga menziesii* was the most important tree species with *Tsuga heterophylla* (Western Hemlock) and *Thuja plicata* (Western Red Cedar) probably limited by low precipitation and soil texture. *Gaultheria shallon* (Salal) was the dominant understory species with *Eurhynchium oreganum* and *Hylocomium splendens* dominating the bryophyte stratum.

Key Words: British Columbia, coniferous forests, ecological reserve, forest structure, old-growth forests, *Pseudotsuga menziesii*.

Ecological reserves have been established in British Columbia primarily for scientific research and related educational purposes pertaining to our natural environment (Krajina 1973). Included within this proclamation (Ecological Reserves Act 1971) is the conservation of natural communities over a long period of time to prevent their alteration by man. The preservation of rare or endangered native plants and animals in their natural habitat is of paramount importance in this concept of conservation.

The selection of reserves has been based largely on the previous ecological classification of the province into biogeoclimatic zones. Saturna Island and its ecological reserve, composed of virgin coastal Douglas Fir forest, are located in the dry subzone of the Coastal Douglas Fir (CDF) zone (Krajina 1965, 1969). An IBP (International Biological Programme) survey of the area was completed in 1968 by T.M.C. Taylor and T.C. Brayshaw (summary sheet of Region 1, Area 4 *in* La Roi et al. 1976).

The objective of this study was to provide a detailed ecological description of the virgin Douglas Fir forest on this reserve. This type of description is essential to the understanding and management of ecological reserves.

Study Area

Saturna Island, comprising approximately 28 km^2, is the most southern Canadian island of the Gulf Islands in the Strait of Georgia. It lies between 48°46′–48°49′N and 123°2′–123°13′W. The Saturna Island Ecological Reserve is composed of two quartersections and encompasses 1.3 km^2. It has a range of elevation of from 150 to 320 m. Figure 1 shows the interior of this Douglas Fir forest.

Weather data for this region are lacking. The study area is characterized by mild temperatures with prolonged cloudy periods, especially in winter, and a small range of temperature seasonally. Fairly wet but mild winters and warm dry summers are prevalent with a long frost-free season. Annual total precipitation is less than 90 cm because of the rain shadow effect of the Olympic Mountains and higher elevations on Vancouver Island.

Methods

Vegetation sampling was done during July and August 1972. The vegetation was analyzed by strata. The tree, shrub, and high-herb strata were sampled (restricted random sampling scheme) by 21 plots, 10 × 20 m each. The low-herb–dwarf-shrub stratum and bryophyte-lichen stratum were sampled by 210 subplots, each 1 × 1 m; 10 were placed systematically within each large plot.

Data were obtained for diameters of all trees over 10 cm dbh (diameter at breast height) in the plots by species; heights of representative trees in plots using a Blume-Leiss altimeter; density of

FIGURE 1. Interior of stand of trees representative of the virgin Douglas Fir forest on the Saturna Island Ecological Reserve.

tree saplings (individuals < 10 cm dbh) by species; density of tree seedlings in subplots by species; percent cover estimates for all plant species in their respective plots and subplots using the coverage scale of Daubenmire (1959, 1968). A complete plant species list for the Saturna Island Ecological Reserve is available from Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Canada K1A 0S2. Vascular plant nomenclature follows Hitchcock and Cronquist (1973), that of bryophytes follows Lawton (1971) and Stotler and Crandall-Stotler (1977), and that of lichens follows Hale and Culberson (1970).

Results

Importance values, absolute measurements, and diameter size classes for the tree stratum are presented in Table 1. The importance value is a summation of percentages of relative density + relative basal area + relative frequency (after Curtis and McIntosh 1951; Bray and Curtis 1957; Curtis 1959). *Pseudotsuga menziesii* has the highest importance value at 190 and the most consistent distribution of size classes throughout the stand. The average percent cover values for trees and saplings are presented in Figure 2. Douglas Fir trees are located on every plot and exhibit consistently high cover values throughout the reserve. This dominant species has a mean cover value of 52%. Unfortunately, it was not possible to obtain core samples from the protected trees on this reserve (regulations prohibit any disturbance of vegetation on ecological reserves), and hence there are no estimates of stand age. Average percent cover values for the three species in the low-shrub stratum and the two fern species in the high-herb stratum are in Figure 2. *Gaultheria shallon* (Salal) is distributed throughout most of the reserve and completely dominates the low-shrub layer. The average percent cover values for the most dominant species in the low-herb – dwarf-shrub and bryophyte strata are presented in

TABLE 1—Importance values, absolute measurements, and diameter size classes for tree species in the Saturna Island Ecological Reserve, based on measurements in 21 plots, 10 × 20 m each

Species	Importance value* (0–300)	Absolute density (ha^{-1})	Absolute basal area ($m^2.ha^{-1}$)	Absolute frequency (%)	Seedlings	<10 cm dbh	>10 cm dbh — size class distribution (cm) density·ha^{-1} 10–	15–	20–	30–	41–	51–	61–	Max. ht. (m)
Pseudotsuga menziesii	189.8	619	39.3	100	3,100	469	162	110	157	100	64	21	5	43.3
Tsuga heterophylla	63.5	154	8.7	62	6,600	429	38	40	33	21	17	5	0	35.1
Thuja plicata	46.7	123	6.6	43	900	374	50	19	38	2	7	5	2	44.2
Total all species	300.0	896	54.6	—	10,600	1272	250	169	228	123	88	31	7	—

*Importance value = Relative density + relative basal area + relative frequency (after Curtis and McIntosh 1951; Bray and Curtis 1957; Curtis 1959).

Figure 3. *Eurhynchium oreganum* completely dominates the bryophyte layer with a mean coverage of 23%. *Hylocomium splendens* is the second most important species with a mean coverage of 5%.

Discussion

Pseudotsuga menziesii is the dominant tree species, constituting the uppermost layer of the forest canopy. This species is suitably adapted to all possible moisture and nutrient levels controlled by the soil and topography on this reserve. The highest productivity of the species in this dry subzone of the CDF zone is a site index of 45 to 48 m at 100 yr. Trees near the base of the slope on this reserve will probably attain this size class at 100 yr. Because this dry subzone is the least productive forest area of all the coastal parts of the mesothermal climatic region in British Columbia (Krajina 1969), *Pseudotsuga menziesii* does not achieve the growth reached by this species in more favorable regions.

Tsuga heterophylla (Western Hemlock) is in low abundance and, in general, trees of this species are smaller than those of *Pseudotsuga*

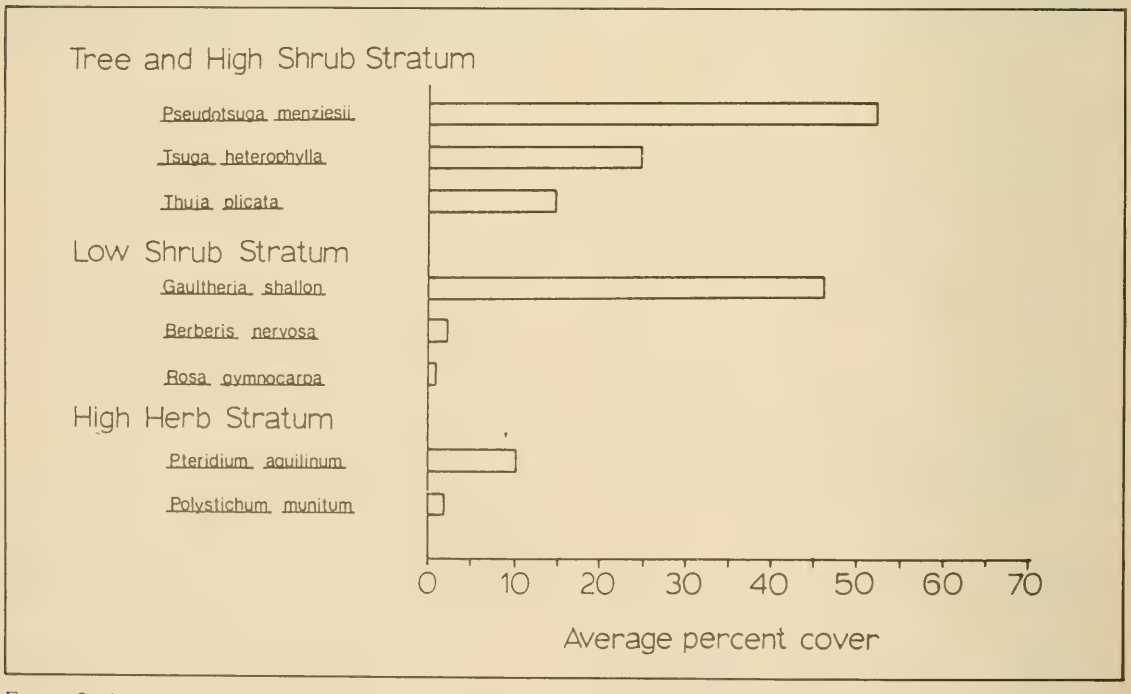

FIGURE 2. Average percent cover values for tree, low-shrub, and high-herb strata in the Saturna Island Ecological Reserve, based on estimates in plots and subplots.

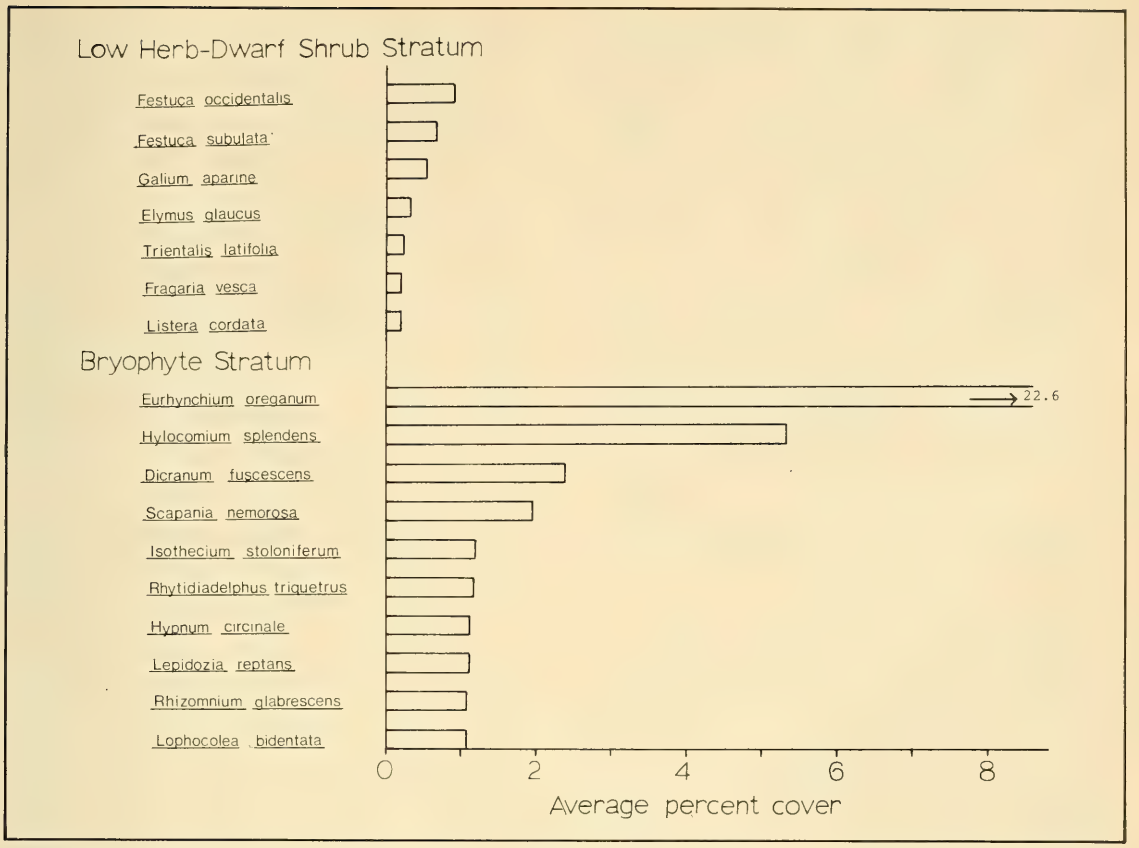

FIGURE 3. Average percent cover values for low-herb – dwarf-shrub and bryophyte strata in the Saturna Island Ecological Reserve, based on estimates in subplots.

menziesii. Most Western Hemlock seedlings and saplings are growing on rotting wood compared with the soil or litter habitat characteristic of Douglas Fir seedlings. This low density and growth on decaying wood is typical of *Tsuga heterophylla* in the dry subzone of the CDF zone, which generally presents limiting factors for the growth of this species. It has a very high shade tolerance and prefers soils which supply low amounts of fairly well balanced nutrients, and these conditions exist only on podzolized soils frequently moistened by rainfall (Krajina 1969). Adequate precipitation (at least 165 cm annually) and a true podzol soil are not present on the ecological reserve, thereby limiting the success of *Tsuga heterophylla*.

Thuja plicata is found downslope in the northern half of the reserve in association with *Tsuga heterophylla* and the dominant *Pseudotsuga menziesii*. It also occurs sporadically in clumps in local topographic depressions where some surface water is present in all seasons except summer. This species has smaller trees than *Pseudotsuga menziesii* but does grow very well at lower elevations. The shade tolerance of *Thuja plicata* is as high as that of *Tsuga heterophylla* but its other ecological characteristics are quite different (Krajina 1969). Precipitation and soil texture, as they affect availability of water and nutrients, are probably limiting factors for *Thuja plicata* and *Tsuga heterophylla* in the Douglas Fir forest comprising this ecological reserve. *Pseudotsuga menziesii* is well adapted to subhumid or even dry climates and if its moderate nutritional requirements are met, it tends to be very successful in both dominance and abundance, relative to other species in this study area.

The associations of the Coastal Douglas Fir zone have been studied and described by Mueller-Dombois (1959) with reference to the Nanaimo Lakes region and adjacent valleys. But there have been no plant community studies on this biogeoclimatic zone on the Gulf Islands.

Three of the seven recognized associations of the Coastal Douglas Fir zone (dry subzone) are present on this ecological reserve. The Salal, moss, and Sword Fern (*Polystichum munitum*) associations are all represented. The Salal association (ca. 65% relative area) is most widespread and occurs with all three tree species. Herbs and bryophytes are suppressed owing to the presence of *Gaultheria shallon*. The moss association (ca. 25% relative area) alternates with Salal in a patchy distribution throughout the reserve. *Eurhynchium oreganum* and *Hylocomium splendens* best represent this community in their appearance as mats on the forest floor.

The Sword Fern association (ca. 10% relative area) is probably best represented on this reserve at lower elevations. Here *Pseudotsuga menziesii* achieves its best growth in both height and diameter. *Thuja plicata* also follows this trend but is still the subdominant species. *Polystichum munitum* is not abundant in the forest but exhibits its highest cover value in this part of the reserve.

A brief discussion of the probable history and future successional status of this forest is of importance to the understanding and management of this ecological reserve. There are a few isolated individuals of *Pseudotsuga menziesii* scattered throughout the forest, which are much larger and older than the majority of trees. Most of these trees, dead and alive, show evidence of fire damage. Also, traces of burnt logs and wood are distributed over the reserve. Therefore, at least part of the area has experienced past fire, which probably affected the growth of trees in the present-day forest. It is possible that the very large trees that survived the fire provided a seed source for regrowth of the Douglas Fir forest. Logging in the past is evident on the extreme eastern part of the reserve but is definitely absent from all other areas.

The future forest will continue to be dominated by *Pseudotsuga menziesii*. Its seedlings are the most evenly distributed of all species and exhibit shade tolerance on all available habitats. The high density of seedlings and saplings of *Tsuga heterophylla* and *Thuja plicata* is due to clumping in restricted habitats, which contrasts with the widespread occurrence of *Pseudotsuga menziesii*. Both these species will remain restricted to specific sites in correlation with water and nutrient requirements.

In the understory, the pattern of Salal, mosses, and open areas should continue to predominate, with suppressed herb and reduced shrub layers due to the shade cast by *Gaultheria shallon*. It is possible that Salal may expand and shade out regions of the moss association if soil moisture and topographic variation do not continue to support this Salal-moss distribution.

Finally, the browsing of vegetation by Columbian Black-tailed Deer (*Odocoileus hemionus columbianus*) may become important if the population density of these animals increases. My sightings of deer during fieldwork indicated that these animals were very abundant throughout the reserve and on Saturna Island in general. The understory species, *Gaultheria shallon*, *Rosa gymnocarpa*, *Pteridium aquilium*, and *Polystichum munitum* exhibited some degree of damage from browsing. Effects on tree seedlings were not noticeable, but according to J. Revel (1963 unpublished report, Faculty of Forestry, University of British Columbia) and Cowan and Guiget (1970), this species of deer prefers seedlings of Western Red Cedar and Douglas Fir. Western Hemlock is usually exempt from browsing. Therefore, the future successional status of this forest could be controlled by the effects of seedling browsing as well as the ecological tolerances already discussed for the three tree species. In addition, deer trails on some downslope regions of the reserve have disturbed the ground cover of mosses exposed to the passage of these animals.

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Colonial-nesting Herring Gulls and Common Terns in northeastern Saskatchewan

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Observations of colonial-nesting birds were conducted during the summers of 1973 and 1974 as part of the Wildlife investigations of the Churchill River Study in northeastern Saskatchewan. Herring Gulls (*Larus argentatus*) and Common Terns (*Sterna hirundo*) were the only species found to breed in abundance within the surveyed area. All of the Herring Gull colonies and the majority of the Common Tern colonies were located on Reindeer Lake, rather than on the smaller lakes and river channels along the Churchill and Reindeer rivers. The mean size of nesting colonies was relatively small compared to those of more southerly latitudes. Favored nesting sites were small rocky islands which were very susceptible to flooding. Common Terns appeared to be better adapted to utilizing the more ephemeral nesting habitat along the river systems than Herring Gulls.

Key Words: Common Terns, Herring Gulls, nesting colonies, habitat, behavior, Saskatchewan.

The breeding range of the Common Tern (*Sterna hirundo*) extends throughout Saskatchewan and that of the Herring Gull (*Larus argentatus*) covers most of the northern half of the province (Gollop 1969). This paper presents gull and tern nesting observations made during the summers of 1973 and 1974 while we were conducting wildlife studies in northeastern Saskatchewan for the Churchill River Study (CRS). The CRS was undertaken by the governments of Canada, Manitoba, and Saskatchewan to assess the potential environmental impact of a proposed hydroelectric dam on the Churchill River 65 km west of the Manitoba-Saskatchewan border (Barber et al. 1975).

The study area lies 300 km northeast of Prince Albert, Saskatchewan, and is characterized by Precambrian rock and boreal forest. The area investigated includes the Churchill River from Drinking Falls to the Island Falls Dam, Manawan Lake, all of the Reindeer River and most of Reindeer Lake (Figure 1).

The primary objective of our gull and tern investigations was the location of nesting colonies to determine population levels and distribution. A secondary objective was an assessment of the nesting habitat.

Methods

High-level black-and-white air photos were examined to locate small isolated islands and shoals representing potential nesting sites. In late June 1973 an aerial survey was flown over most of Reindeer Lake to check these locations and numerous others for signs of nesting activity. Nest sites on the Churchill and Reindeer rivers were located during the course of other wildlife aerial and ground surveys.

Once during late June or early July of each year a sample of nesting islands was examined on the ground to determine numbers of nests, eggs, young, and adults, as well as nesting habitat characteristics. Colonies on Reindeer Lake were examined between 19 and 23 June in both years. In 1974 elevations of islands and individual nests above water level were surveyed at 10 selected colony sites using a Cooke survey transit and stadia rod. Nest distribution and substrate characteristics were also noted.

Results

Common Terns

Twenty-seven colonial nesting sites were located, 17 on Reindeer Lake, 4 on the Churchill River, 4 on the Reindeer River, and 2 on

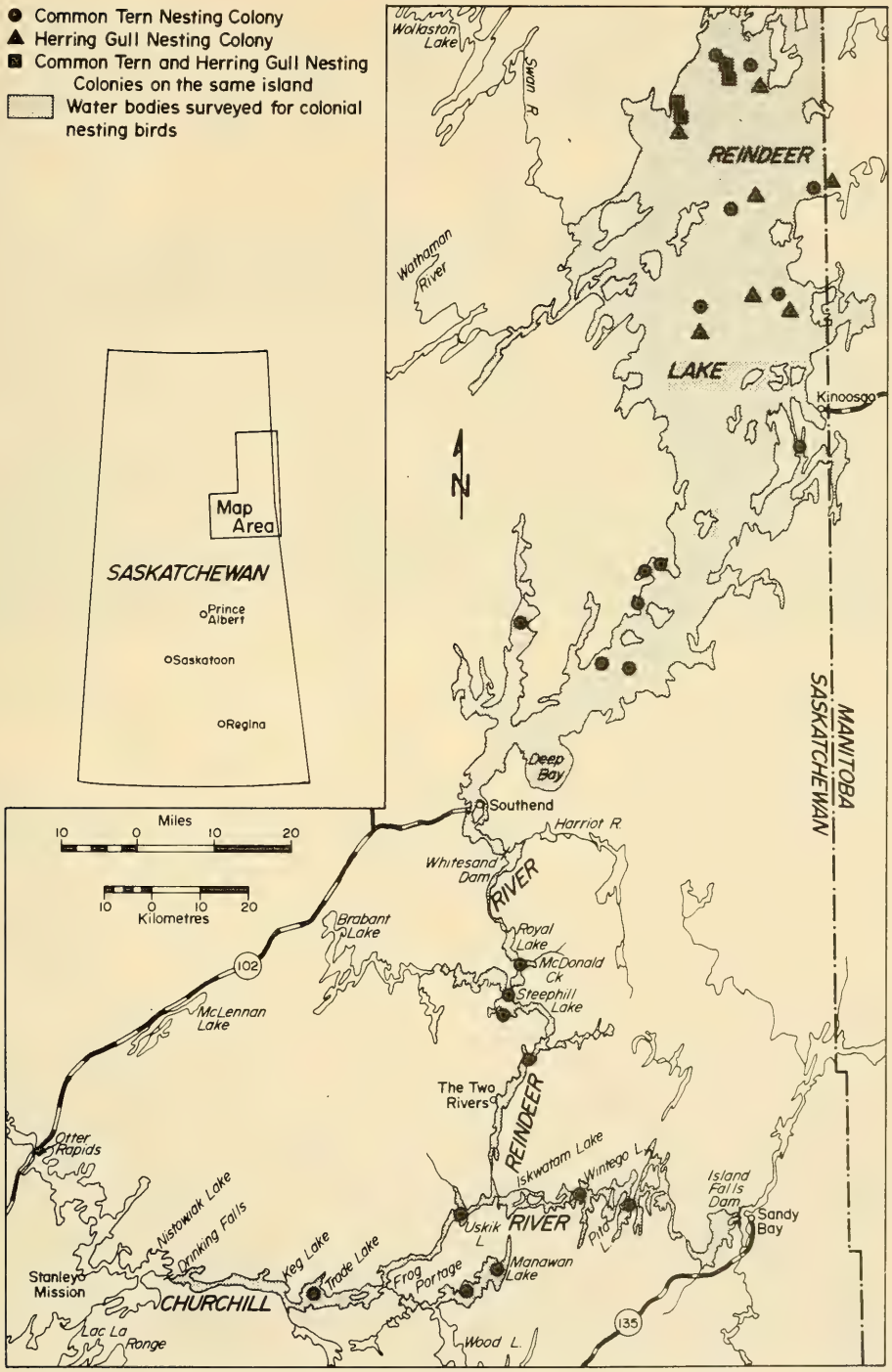

FIGURE 1. Location of Common Tern and Herring Gull nesting colonies within the study area.

TABLE 1—Number and average size of Common Tern and Herring Gull nesting colonies

Location	Number of colonies located (and sampled)		Mean number (and range) of adults per sampled colony		Mean number (and range) of nests per sampled colony	
	1973	1974	1973	1974	1973	1974
Common Terns						
Reindeer Lake	13(5)	15(6)*	23(10–45)	25(6–50)	12(4–26)	21(5–38)
Reindeer River	2(2)	3(3)**	34(18–50)	55(35–66)	19(9–28)	25(11–33)
Churchill River	4(3)	flooded	28(8–45)	—	14(9–22)	—
Manawan Lake	2(2)	not surveyed	43(40–45)	—	29(17–40)	—
Means			29	35	16	23
Herring Gulls						
Reindeer Lake	9(5)	7(7)***	19(10–55)	18(6–45)	13(2–31)	13(3–22)

*Includes five colonies not sampled in 1973.
**Includes two colonies not sampled in 1973.
***Includes four colonies not sampled in 1973.

Manawan Lake (Figure 1). Not all colony sites were used in both years. In 1974, colony sites on the Churchill River were completely flooded as a result of unseasonally high water levels.

Mean colony size was small, ranging from 16 nests in 1973 to 23 in 1974 (Table 1). The two colonies on Manawan Lake were relatively large, averaging 29 nests in 1973. Colonies examined on Reindeer Lake averaged only 12 nests in 1973 and 21 nests in 1974.

By 21 June, most colonies had nests with eggs, with mean clutch sizes ranging from 1 to 2.8. On 20 June 1973, however, two colonies on Reindeer Lake had several adult birds and nest depressions with no eggs, whereas a colony on the Reindeer River had the first young hatching on 23 June 1973. Reliable productivity data were not obtained because most sampled colonies were visited only once during the season.

Some loss of eggs from flooding was observed, with low near-shoreline nests being washed over during storms and strong winds. Heavy rains which resulted in sharply rising water levels also took their toll. One colony on Reindeer Lake examined on 23 June 1974 had recently been destroyed by humans: 10 adult terns remained on the shoal but no re-nesting had been initiated.

Herring Gulls

Eleven different colony sites were located, all on Reindeer Lake. Four of these were shared with Common Terns (Figure 1). In addition, a single Herring Gull nest with eggs was at a Common Tern colony of Steephill Lake (Reindeer River) in both 1973 and 1974, and lone Herring Gull nests were observed at four locations on Reindeer Lake, three of these being associated with Common Tern nesting sites.

Colonies averaged 13 nests in 1973 and 1974 (Table 1). In 1973 most nests contained eggs, while in 1974 a large percentage of the nests attended by adults contained no eggs.

Nest Island Characteristics

All Herring Gull and Common Tern nesting islands were very low (<3 m above water level) and small (<1000 m^2), except for one larger Herring Gull nesting island (Colony #10, see Table 2). Generally less than 50% of the surface of nest islands supported vegetation, primarily grasses, forbs, mosses and lichens, with an occasional shrub or tree. But Colony #10 in Table 2 and a Common Tern colony on the Reindeer River (Figure 2) had 70–80% of their surface area covered by shrubs and trees, whereas several islands had no growing vegetation (Figure 3). The vegetation and small amount of associated soil occurred on the higher portions of nesting islands where there was no extensive erosion by ice and wave action.

The substrate of nesting islands varied from large fragmented blocks to smoother solid rock and scattered boulders and stones. Occasionally some finer sand and pebble deposits were present near the water's edge. Driftwood was strewn over the lower portions of some islands and completely covered one (Colony #4, Table 2).

FIGURE 2. Common Tern nesting colony on Steephill Lake (Reindeer River).

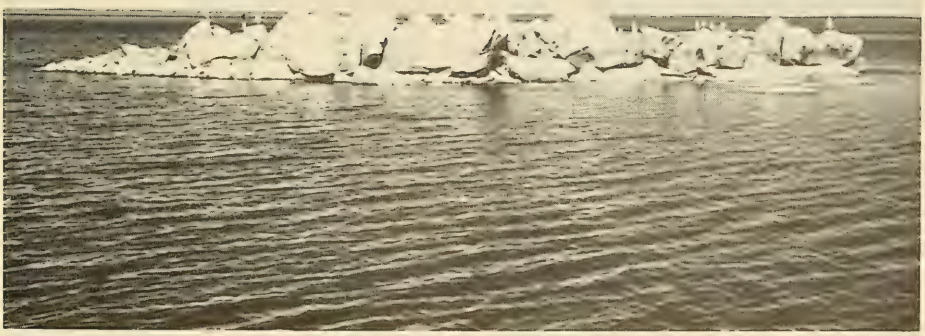

FIGURE 3. Herring Gull colony.

TABLE 2—Island size and nest distribution for 10 Herring Gull and Common Tern nesting islands on Reindeer Lake, 1974

Colony	Island height (m)	Island area (m^2)	Species	Number of nests*	Nest height above water (m)**	
					Mean	Range
1	1.6	155	Common Tern	5	0.4	0.3–0.4
2	2.1	349	Common Tern	19	0.6	0.4–0.8
			Herring Gull	1	1.3	
3	1.0	697	Common Tern	38	0.4	0.2–0.5
			Herring Gull	1	1.0	
4	0.8	387	Common Tern	16	0.2	0.1–0.4
			Herring Gull	3	0.5	0.2–0.8
5	3.1	960	Common Tern	36	1.2	0.2–2.0
			Herring Gull	1	0.2	
6	2.4	968	Common Tern	14	0.9	0.8–1.1
			Herring Gull	22	0.8	0.5–1.1
7	2.4	465	Herring Gull	22	0.5	0.1–0.8
8	2.9	426	Herring Gull	6	0.5	0.3–0.8
9	2.1	426	Herring Gull	10	0.8	0.5–1.4
10	2.0	3988	Herring Gull	13	0.5	0.2–1.1
Means	1.8	586	Common Tern		0.7	
	2.1	1083	Herring Gull		0.7	

*All recognizable nests, with or without eggs, were included in the measurements.

**All measurements were taken from 21 to 23 June 1974 when the water level on Reindeer Lake was 331.1 m (1103.8 ft.) above sea-level.

Distribution of Nest Sites

Common Tern nests were usually located near the lower edge of the vegetated portions of islands among scattered grass tussocks and moss-lichen mats. Nests were sometimes nothing more than a shallow depression in a thin layer of soil, or a crevice in the rock. Herring Gulls constructed nests of grasses and small twigs, frequently on exposed rocks or pieces of driftwood, affording a good vantage point.

The mean height of both tern and gull nests above late June water levels in 1974 was 0.7 m (Table 2). No nests were located more than 2.0 m above water level. The mean nearest-neighbor distance between the edges of Common Tern nests was 0.9 m, with the closest nests being only 0.3 m apart. The mean distance between adjacent Herring Gull nests was 3.3 m, while the shortest distance was 2.1 m.

Discussion and Conclusions

Herring Gulls and Common Terns were the only species of Laridae found to breed in abundance within the study area. All of the Herring Gull colonies and most of the Common Terns were found on Reindeer Lake rather than the smaller lakes and river channels to the south (cf., Vermeer 1975). This distribution is thought to reflect the more stable nesting conditions on Reindeer Lake, where water levels are not subject to rapid large-scale fluctuations such as those that occur on the rivers.

Common Tern colony locations and sizes on the Churchill and Reindeer rivers changed from 1973 to 1974 because of late spring flooding in 1974. McNicholl (1975) points out that in unstable habitats larids generally demonstrate reduced nest site tenacity and increased group adherence, thus aiding the rapid pioneering of alternate nesting habitat. The shifting nest site locations and relatively larger average size of Common Tern colonies that we observed in 1974 on the river system support this theory. We observed no evidence of Common Terns nesting singly, while we found five such cases in Herring Gulls. Several other cases of Herring Gulls nesting as single pairs have been reported in the literature (Harper 1953; Nero 1963; Vermeer 1975). In general our data would suggest that nest site tenacity is stronger in the Herring Gulls while group adherence is stronger in the Common Terns, thus enabling the terns more successfully to colonize riverine habitats.

A noteworthy feature of our tern and gull nesting colonies is their small mean size. This appears to be characteristic for these more

northern latitudes as indicated by other workers (Mowat and Lawrie 1955; Scotter 1961; Nero 1963, 1967; Weber 1976). No colonies of over 100 nests were reported for either species and most were considerably smaller. By contrast, Common Tern colonies in southern Saskatchewan are characteristically large, ranging in size from 100 to 1000 nests (Ferry 1910; Lahrman 1957; Sanderson 1966; C. S. Houston, personal communication). In the Great Lakes, Common Tern colonies may number over 2500 birds, and Herring Gull colonies usually exceed 100 birds (Morris and Hunter 1976). Vermeer (1975) studied one Herring Gull colony of 161 nests at Kawinaw Lake in southern Manitoba. Several factors may account for such variation. Differential biological productivity and food availability is likely a primary factor (cf., Vermeer 1970). The waters in our study area are relatively nutrient-poor (oligotrophic) and have a cover of ice until mid- to late May. The size and distribution of nest islands, plus predation factors, may be important as well.

Favored nesting sites of both gulls and terns were very low, small, rocky islands with restricted vegetation growth. Wind, wave and ice action are believed to be important elements in maintaining the exposed mineral substrates and sparse vegetation cover utilized for nesting. Nest sites thus occurred within a few feet of surrounding water levels and were very susceptible to flooding from both natural and artificial water level increases.

A hydroelectric dam and reservoir as proposed by Saskatchewan Power Corporation at Wintego Rapids* on the Churchill River would result in water levels rising 28.5 m at Wintego Lake, 5.3 m at Steephill Lake, and 2.3 m at Keg Lake. All eight of the islands used for nesting by Common Terns on the Churchill and Reindeer rivers would be flooded; however, at least 11 new potential nesting islands would be created by the flooding. Reindeer Lake, which would be included within the proposed reservoir, would not exceed its historical levels, resulting in no change in numbers and locations of nesting islands.

Once filled and operational, reservoir water levels would steadily rise a full 1.2 m from 1 May to 1 November to replace the winter drawdown. Much of this rise would come in June and July when runoff is heaviest (Hofer 1975). Our data on the distribution of gull and tern nests (Table 2) suggests that on suitable nesting islands within the proposed Wintego Reservoir a 0.7-m increase in water levels during June and July would flood more than 50% of the gull and tern nests.

Further studies are needed at these northern latitudes to understand more fully the factors influencing population distributions and productivity. It is necessary to have a better understanding of behavioral responses to changing environmental conditions, as well as food and nesting habitat requirements, before one can reasonably predict the possible impacts of future northern developments on colonial-nesting gulls and terns.

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*On 18 September 1978 the Government of Saskatchewan, following the recommendation of the Churchill River Board of Inquiry, announced that it would not permit construction of the proposed hydroelectric installation at Wintego Rapids.

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Epiphytes on White Elm, *Ulmus americana*, near Thunder Bay, Ontario

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White Elm (*Ulmus americana*) stands near Thunder Bay, Ontario were investigated for epiphyte cover. Lichens dominated the cover in upper quadrats and mosses dominated in quadrats near the ground. In both upper and lower quadrats, mean cover was about 10%. Total cover was greatest on the north sides of the trees and tended to increase as the distance from the city increased. The stand located close to a kraft pulp and paper mill had the lowest number of species. Three species of liverworts, 12 mosses, and 17 lichens were recorded.

Key Words: northern Ontario, White Elm, epiphytes, pollution.

White Elm, *Ulmus americana*, is rapidly disappearing from much of its former range in Canada and the United States owing to large-scale mortality caused by the introduced Dutch Elm Disease. This unfortunate circumstance has resulted in increased interest in studies relating to White Elm, such as that of Mahoney (1973) in northern Michigan and Newberry (1974) in Wisconsin. A further point of interest is that the groves in our region, the northwest shore of Lake Superior, form part of the northern boundary of White Elm's range. The purpose of this study was to record the epiphytes on White Elm near Thunder Bay before Dutch Elm Disease removes the elm population, and to note epiphyte variability in relation to distance from the city of Thunder Bay.

Methods

During September and October of 1973, 50 trees were examined in five natural stands (10 trees per stand) located at various distances from the city of Thunder Bay. These stands were as follows:

1. Great Lakes Paper. On the south bank of the Kaministiquia River directly south of the Great Lakes Paper kraft pulp and paper mill. This small stand is on the south end of Thunder Bay city and is considered to be at 0 km (48°21′W, 89°19′N, 194 m above sea-level (asl)).
2. Pointe de Meuron. This relatively large stand of elm is on the north bank of the Kaministiquia River adjacent to the reconstructed Old Fort William and is 3 km west of the Great Lakes Paper site (48°21′W, 89°21′N, 195 m asl).
3. Slate River. This medium-sized stand is on the west bank of the Slate River just north of Highway 608 and is 16 km southwest of Great Lakes Paper (48°16′W, 89°29′N, 224 m asl).
4. Kakabeka Gorge. This is a small stand located on the east bank of the Kaministiquia River about 300 m downriver from Kakabeka Falls (36 m high) and is 23.4 km west-north-west of Great Lakes Paper (48°24′W, 89°37′N, 229 m asl).
5. Blind Line Road. This small stand is on the south bank of a small creek just north of Blind Line Road and 250 m west of Highway 11-17. This site is 25.6 km west-north-west of Great Lakes Paper (48°25′W, 89°38′N, 284 m asl).

All sites have Balsam Poplar (*Populus balsamifera*), Black Ash (*Fraxinus nigra*), Mountain Maple (*Acer spicatum*), and Red-osier Dogwood (*Cornus stolonifera*). Also generally present are Eastern White Cedar (*Thuja occidentalis*), White Birch (*Betula papyrifera*), Speckled Alder (*Alnus rogosa*), and Red Raspberry (*Rubus idaeus*). Table 1 shows additional characteristics of the sites and of the trees in the stands.

TABLE 1—Mean soil and tree characteristics. DBH = Diameter at breast height (range in parentheses)

Site	Soil pH	% Carbon	Trees, DBH (cm)	Bark pH
Great Lakes Paper	5.9	11.0	44.9 (30.5–71.1)	4.2
Pointe de Meuron	5.9	13.1	37.7 (19.7–55.9)	6.2
Slate River	5.8	14.4	38.0 (22.9–49.5)	6.4
Kakabeka Gorge	6.8	5.3	24.8 (17.2–45.7)	6.5
Blind Line Road	6.4	18.8	21.3 (15.9–31.8)	6.6
Mean	6.2	12.5	33.3 (15.9–71.1)	6.0

TABLE 2—Presence (X) and frequency of epiphytes on White Elm at the five study sites. Frequency figures are out of a possible total of 50 trees. *t* = found only in top quadrats; *b* = found only in bottom quadrats; no notation = found in both top and bottom quadrats. GLP = Great Lakes Paper; PM = Pointe de Meuron; SR = Slate River; KG = Kakabeka Gorge; BL = Blind Line Road

	Presence					Frequency		
Species	GLP	PM	SR	KG	BL	Top quadrats	Bottom quadrats	Whole tree
Frullania eboracensis		X	X	X	X	28	15	31
Frullania bolanderi				X		5	1	5
Porella platyphylla		X^b		X^b		0	2	2
Anomodon minor	X^b	X	X		X	6	20	20
Orthotrichum speciosum			X	X^t	X	15	7	19
Brachythecium salebrosum		X		X	X	8	13	15
Pylaisiella selwynii		X	X		X	5	7	11
Pylaisiella polyantha		X^t		X		10	10	11
Brachythecium reflexum		X		X^b	X	3	3	5
Platydicta subtile	X					1	5	5
Plagiothecium denticulatum		X^b				0	2	2
Amblystegium juratzkanum				X^b		0	1	1
Orthotrichum obtusifolium				X^t		1	0	1
Dicranum montanum	X^b					0	1	1
Mnium cuspidatum					X^b	0	1	1
Physconia grisea	X	X	X	X	X	30	23	33
Candelaria concolor		X^t	X	X	X^t	28	10	29
Parmelia sulcata	X	X	X^t		X	21	9	21
Physcia orbicularis		X	X	X	X	18	6	19
Physcia adscendens			X	X^t	X^t	11	3	12
Physcia aipolia		X		X^t	X	7	3	9
*Bacidia chlorococca**	X					4	7	8
Lepraria membranacea		X				3	4	5
Lecanora impudens		X	X		X	3	3	4
Lobaria pulmonaria		X	X^t		X	4	1	4
Xanthoria polycarpa				X^t	X^t	4	0	4
Cetraria ciliaris			X^t			3	0	3
Lecanora conizaea		X				2	2	3
Evernia mesomorpha		X^t				2	0	2
Lepraria neglecta		X				1	1	2
Parmelia saxatilis		X^t				2	0	2
No. of species, top	4	18	12	12	15	$\overline{X}$ = 12		
No. of species, bottom	6	16	9	10	13	$\overline{X}$ = 11		
No. of species per tree	6	20	12	15	16	$\overline{X}$ = 14		

**Bacidia chlorococca*, while not noted in the quadrats, was also present on the elms at both Slate River and Blind Line Road.

Each of the 10 trees in each stand was analyzed for epiphyte presence using the method employed by Rao and Le Blanc (1967). In this method, two circular quadrats were used per tree. One quadrat (bottom) was from the tree base at 0 cm to 30 cm above the base; the second quadrat (top) was also 30 cm deep and was located at 120 cm to 150 cm above the tree base.

All mosses, liverworts, and lichens were recorded. Cover was also estimated using the Domin Scale for this purpose. Conversion of the Domin Scale data to percent cover was based on the following equivalents: 10 = 100%, 9 = 75%, 8 = 60%, 7 = 40%, 6 = 30%, 5 = 20%, 4 = 5%, 3 = 3%, 2 = 1%, 1 = 0.5% and X = 0.25%. The directional quarter of greatest cover for each tree was noted.

Sorensen's Coefficient of Similarity was used to compare quadrats and trees and also as a basis for a Bray and Curtis (1957) ordination in which each tree (top and bottom combined) was used as one quadrat.

All field studies were done by the second author. Determinations were also done by the second author with assistance from C. Garton (bryophytes) and the first author (macrolichens). All crustose lichens were verified by J. W. Thompson. Voucher specimens were deposited in the Lakehead University Herbarium.

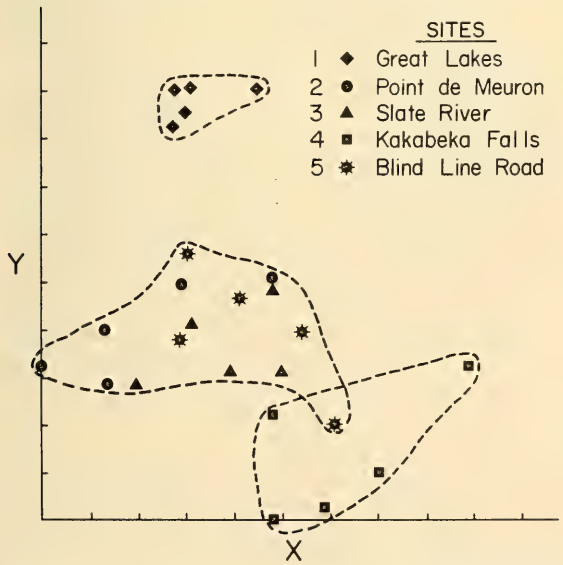

FIGURE 1. An ordination of whole trees from five sites using the Sorensen Coefficient of Similarity method of Bray and Curtis (1957).

Results

The species of lichens and bryophytes present at each site, the number of species per tree, the number of species in top quadrats, the number of species in bottom quadrats, and the number of species per site in all quadrats are shown in Table 2. The total number of species for all sites is 32, made up of 3 hepatics, 12 mosses, and 17 lichens.

The coefficient of similarity ordination of whole trees is illustrated in Figure 1 to show relationships between sites.

Percent cover values by site are shown in Figure 2. When all five sites are considered

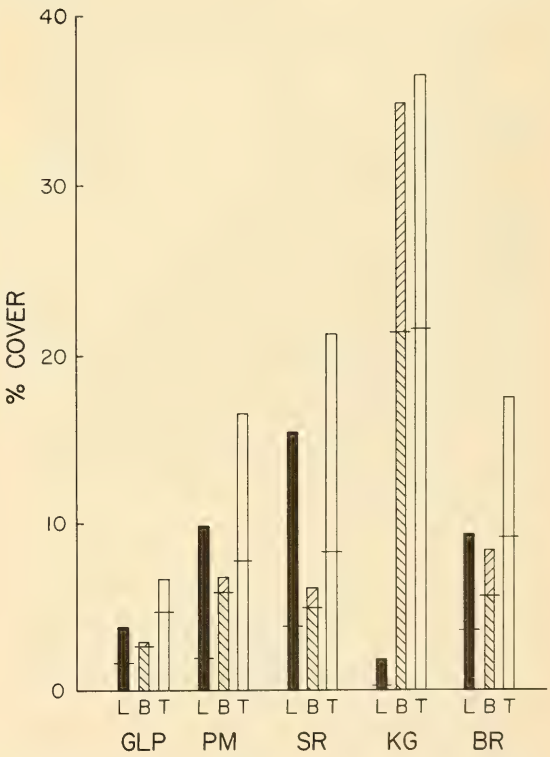

FIGURE 2. Cover relationships of bryophytes and lichens showing values for top quadrats (above line) and bottom quadrats (below line) at the five study sites. The sites are arranged in order of increasing distance from Thunder Bay. L, lichens; B, bryophytes; T, total of both lichens and bryophytes; GLP, Great Lakes Paper site; PM, Pointe de Meuron site; SR, Slate River site; KG, Kakabeka Gorge site; BR, Blind Line Road site.

together, lichens contribute a mean cover of 5.9% in the top quadrats and 2.1% in the bottom quadrats. Byrophytes contribute 3.6% in the top quadrats and 8.0% in the bottom quadrats. Overall mean epiphyte cover was 9.5% in the top quadrats and 10.2% in the bottom quadrats. In 68% of the trees the greatest cover is on the north quarter of the trees, 14% on the west, 10% on the east, 2% on the south, and in 6% two or more quarters were equal.

Discussion

The most obvious observation from the data obtained in this study is that the Great Lakes Paper site is quite different from the other four areas. The number of species of epiphytes in each of the three groups, and the total number of species for all groups, are significantly lower ($P \leqslant 0.01$) in the Great Lakes Paper site than in any of the other areas. This is perhaps even more significant when related to the mean DBH (diameter at breast height) of the stands, as Great Lakes Paper has the highest mean DBH of any of the areas, indicating greater age which often results in high epiphytic cover. The bark pH of 4.2 of the Great Lakes Paper site was much lower than on the other sites, which had a mean bark pH of 6.4. The emissions from the nearby pulp mill are probably responsible for the singular character of this site when compared to the other four sites. The mean bark pH of 6.0 is, incidentally, comparable to that found by Skye (1968) for *Ulmus* sp. in the Stockholm region, and also for White Elm in Central Wisconsin (Newberry 1974).

When all sites are considered together as representative of the Thunder Bay region, the number of species of lichens compares favorably with the number noted by Mahoney (1973) on White Elm in northern Michigan, where 15 species were found in one area and 8 species in another for a total of 17.

Other publications that have included data on White Elm epiphytes are Hale (1952, 1955), Culberson (1955), Le Blanc and De Sloover (1970), and Newberry (1974). For various reasons (e.g., data for elm are combined with that of other species: whole trees were investigated: trees were of urban environments) comparison with all but Newberry (1974) are perhaps not very useful, except for the obvious conclusion that generally the more trees and the larger the area of the tree included, the greater the number of epiphyte species that will be encountered. Newberry's (1974) study, however, does give separate White Elm data and is related to sulphur dioxide emissions from a kraft paper mill. In Newberry's study a species list is not included but 18 species and three varieties of lichens are common on White Elm and eight more lichen species are classified as rare (six more fruticose lichens are present but the phorophyte is not specified). *Candelaria concolor, Parmelia sulcata, Physcia orbicularis,* s.l., and *Physconia grisea* are apparently common in Thunder Bay as well as in northern Michigan and central Wisconsin. *Physcia setosa,* the most common lichen in the Michigan study, is rare in Thunder Bay and was not noted on the elms studied. *Physcia elaeina*, a ubiquitous species in Wisconsin, has not been reported in the Thunder Bay region. *Parmelia rudecta* and *P. caperata* were present in both the American studies, but although present in Thunder Bay, were not recorded on the elms investigated. One of the most common epiphytes in the Thunder Bay area is *Hypogymnia physodes*. This species, however, was not noted on the White Elms of this study or by Mahoney (1973) in Michigan and was reported as rare in Wisconsin, indicating if not phorophyte specificity at least phorophyte preference.

Although the bryo-flora was not considered by Mahoney (1973) or Newberry (1974) some general comments are perhaps warranted. None of the three liverworts found are rare. But, while *Frullania eboracensis,* the most common epiphytic hepatic in this study, is also one of the most common in the Thunder Bay region the other two species are scarce. In the mosses, moreover, *Anomodon minor*, the most common moss on elm, is also scarce, and *Hypnum pallescens*, usually a very common epiphytic moss, was not recorded on any of the 50 elms studied.

Table 2, besides showing the species present, clearly indicates that liverworts and lichens are more common in the upper quadrats and that the mosses are more common in the lower quadrats.

The ordination (Figure 1) based on presence-absence data also shows the Great Lakes Paper

site to be rather different from the other four sites. The Kakabeka Gorge site is set off as well, but not to the same extent and the ordination indicates relationships among the Pointe de Meuron, Slate River, and Blind Line Road sites. A second ordination using the reciprocal averaging technique (Hill 1973) gave essentially the same results except that the Kakabeka Gorge stand is quite separate from the other groups.

The cover relationships between groups are similar to the species numbers relationships, with bryophytes being greater in the lower quadrats and lichens greater in the upper quadrats. Cover relationships between sites, however, are quite different from species numbers relationships. In Figure 2 the sites are arranged according to increasing distance from Thunder Bay City. Coincidentally, this is in decreasing order of tree DBH which probably represents decreasing mean age of stands as well. Increasing distance from Thunder Bay results in increasing cover, attributable at least in part to decreasing aerial pollutants. The pattern is not as straightforward as this, however, as the very high bryophyte cover at Kakabeka Gorge must be related to the higher humidity levels resulting from spray from nearby Kakabeka Falls. In any event the Great Lakes Paper site has the lowest cover values and Blind Line Road, although it is apparently the youngest stand, has cover values equivalent to those of the larger-diameter trees at both Pointe de Meuron and Slate River.

In conclusion it can be stated that the epiphyte flora of White Elms near Thunder Bay is relatively comparable to the floras of elms in Michigan and Wisconsin. Also, if Dutch Elm Disease, which was first reported near Thunder Bay in 1976 (Anonymous 1976), should become severe in these isolated stands of elms in this northern part of the tree's range, some record is now available of the present epiphyte flora.

Acknowledgments

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Habitat Utilization and Population Densities of the Amphibians of Northeastern Alberta

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During 1976 and 1977 a survey of the herpetofauna of boreal forest habitats of northeastern Alberta was undertaken. The Wood Frog (*Rana sylvatica*) was the most abundant and widespread species and was collected at 24 of 25 sites examined. Boreal Chorus Frogs (*Pseudacris triseriata maculata*) and Canadian Toads (*Bufo hemiophrys*) were common but found at less than half of the study sites. All three species had spawned prior to 12 June. Natural ponds and borrow pits were the most frequently used spawning sites. Canadian Toads also spawned in flowing water and lake margins. All species had metamorphosed by early August. Wood Frogs metamorphosed at a mean snout–vent length of 17.2 mm, Canadian Toads at 12.4 mm, and Boreal Chorus Frogs at 13.7 mm. Spawning for each of these species probably does not occur until individuals are in their third summer of life. Population densities of Wood Frogs, Boreal Chorus Frogs, and Canadian Toads reached estimated maxima of 19.6, 2.3, and 12 per 1000 m^2 during 1977. Maximum densities of all species were found within 50 m of the nearest water body in moist habitat vegetated by sedges, grasses, horsetails, willows, and poplar. Lower densities were found in upland mixed woods and no anurans were found in dry areas with sandy substrate and Jack Pine forest. Other amphibian and reptile species were not encountered.

Key Words: habitat, population densities, boreal forest, Alberta, Wood Frog (*Rana sylvatica*), Boreal Chorus Frog (*Pseudracis triseriata maculata*), Canadian Toad (*Bufo hemiophrys*).

The herpetofauna of northeastern Alberta is poorly known. Only a few locality records for four species of amphibians and a single reptilian species exist for northeastern Alberta (Logier and Toner 1961). The Canadian Toad (*Bufo hemiophrys*), the Boreal Chorus Frog (*Pseudacris triseriata maculata*), and the Wood Frog (*Rana sylvatica*) are known from the Fort McMurray area (University of Alberta Museum of Zoology = UAMZ collections). Little has been published regarding the abundance and life histories of these species within Alberta, especially in the northern half of the province. Harper (1931) reports the occurrence of the Leopard Frog (*Rana pipiens*) and Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) in the extreme northeastern corner of Alberta. The present study was undertaken to determine reproductive phenology, habitat utilization, and population densities of the three amphibian species commonly found in the boreal forest region of northeastern Alberta.

Most amphibians and reptiles appear to have well defined home ranges (Porter 1972). Quantitative studies of home ranges have been conducted for the Wood Frog by Bellis (1965), the Chorus Frog by Kramer (1973, 1974), and the Canadian Toad by Breckenridge and Tester (1961). The tendency for individuals to spend extended periods of time at a given locality permits population estimates to be made by "total" counts, that is, the sum of individuals marked (counted) within a given area. Such counts may be higher than the actual number present within an area at a given time. This overestimate is the result of (1) counting all (or nearly all) true residents plus a number of transients; (2) counting individuals whose home ranges do not lie completely within the study plots; (3) mortality not being taken into account.

The studies by Breckenridge and Tester (1961), Kramer (1973, 1974), and Bellis (1965) were conducted in relatively small areas and thus provide a limited amount of comparative information with respect to habitat preferences. Information on habitat utilization can be obtained by conducting regular periodic censuses of a large number of sample sites selected to include a wide range of habitat types.

Study Area

Twenty-four potential spawning sites (Figure 1) were selected in 1976 and 1977 within the boreal forest region of northestern Alberta. These sites consisted of 12 streams, five borrow pits (excavations resulting from the removal of

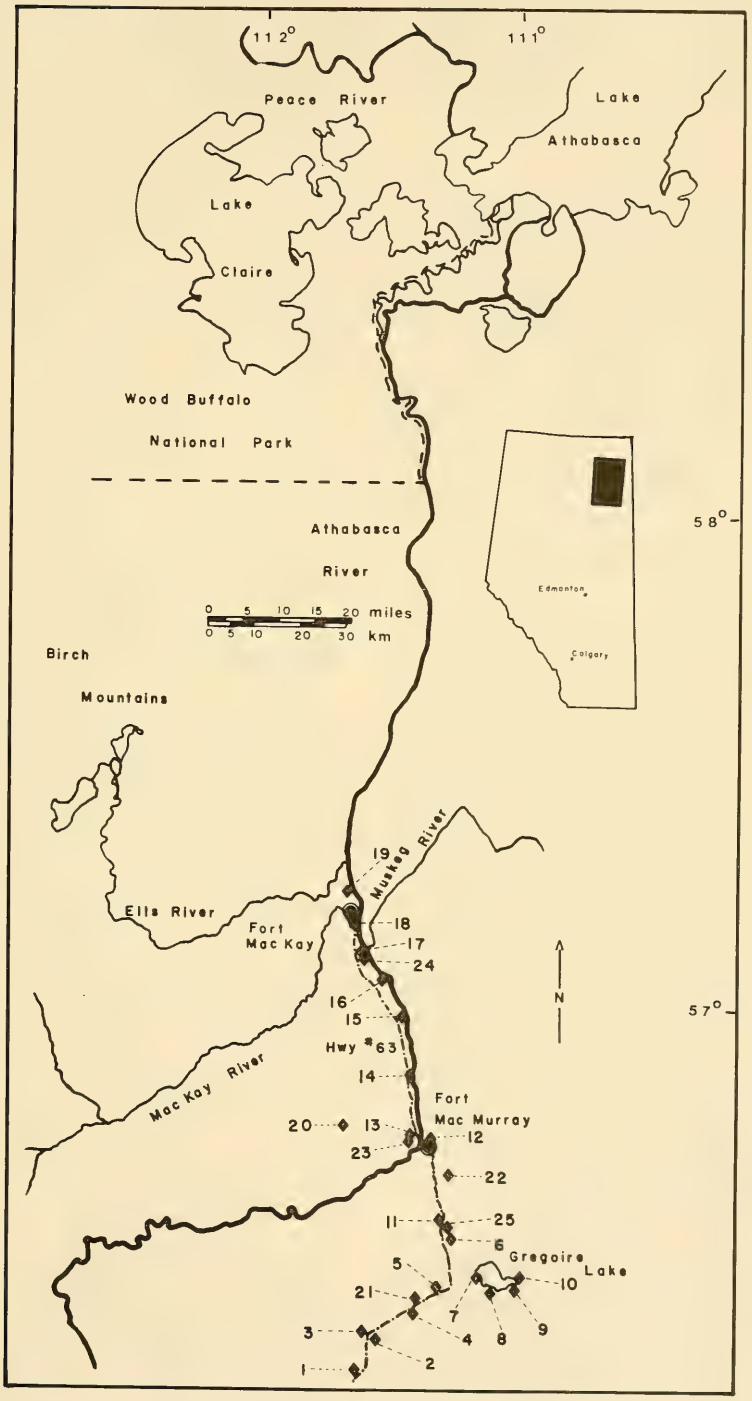

FIGURE 1. Location of amphibian study sites in northeastern Alberta.

road building materials), four natural ponds, portions of the shores of two lakes, and a bog. During 1977, 16 of these sites plus a dry Jack Pine (*Pinus banksiana*) ridge were studied to determine habitat utilization and population density.

Methods

Each site was visited during the day at least eight times during June, July, and August and the amphibian species present, and their abundance, were recorded in the following manner. The visits were equally distributed during mornings and afternoons and as well between cool and warm days for each site. During each visit the observer walked completely around the margins of ponds and borrow pits or for a fixed distance (approximately 400 m) along the margins of lakes or flowing waters. Amphibians observed were identified to species and the numbers of individuals of each were recorded. Individuals were assigned to developmental stages (if larvae) or size classes (if terrestrial) in order to describe their development, time of metamorphosis, and growth during their first year of life. The following arbitrary classes were employed, with equivalent stages of Gosner (1960) given in brackets: (1) eggs (1–25); (2) tadpoles without limbs (26–31); (3) tadpoles with hind limbs present (32–40); (4) tadpoles with four limbs present (41–42); (5) transforming tadpoles (semi-aquatic or terrestrial with tail still evident) (43–45); (6) young-of-the-year with tail completely resorbed (46); (7) yearlings (the smallest size class of subadults or adults); (8) adults (large subadults and adults). The smaller number of classes or stages distinguished by relatively gross differences facilitates the describing of large numbers of larvae in the field.

The head-body lengths (= length) of post-metamorphic frogs and toads were measured to the nearest 0.1 mm according to Conant (1975). Small subadults were similarly measured, up to and including the time of metamorphosis of young-of-the-year. Young-of-the-year were measured again in late August. The data should provide objective criteria for distinguishing underyearling (class 6), yearling (class 7), and older (class 8) individuals, as preliminary observations here indicate that these groups occur in mutually exclusive length-frequency groups.

Subsamples of aggregations of larvae were collected and preserved in 10% formalin. These were later identified to genus using keys in Blair et al. (1968). Specimens of each species and their developmental stages from each site were collected throughout the study and deposited in the University of Alberta Museum of Zoology (Accession number 76-31).

At each habitat sampling site three plots, 10×100 m, were established at right angles to the water body (if present). Where more than one habitat type was present the plots were established so that all types were sampled. Where a water body was present the following information was recorded: basin morphology, submergent and emergent vegetation present. Owing to the large area encompassed by the sample plots only the dominant vegetation types were mapped for each plot.

A census of each of the sample plots was taken 10 times during the summer of 1977. During each visit the observer noted weather conditions, walked the plot, traversing its width 20 times going away from the pond edge and 20 times on the return trip to the pond in a crisscross pattern. During each visit the species present, age class (as determined by length), location on the plot, and habitat type with which each individual was associated was recorded. Subadults and adults were marked by removal of the phalanges distal to the web on one digit of the left hind foot; thus they were not individually marked. The population of adults on each plot was regarded as the total number of individuals so marked.

The sample plots were subdivided by orange surveyor's tape placed at 20-m intervals. Individuals found between the water margin and the 20-m marker were assigned the mean value of 10 m, and individuals found between 20- and 40-m markers were assigned the mean value of 30 m and so on for purposes of calculating the mean distance that each species was found from the water margin during each month of the study.

Results and Discussion

During the 1976 survey 478 adult and subadult amphibians were counted of which 225 were Wood Frogs, 207 Canadian Toads, and 16 Boreal Chorus Frogs. No spawning pairs or egg masses were found during the present study.

Tadpoles were present in all of the known spawning sites during mid-June.

Abundance, Spawning, and Development

Wood Frog

The Wood Frog was present at all sites and spawned in 14 of the 24 sites studied. This species spawned in natural ponds, borrow pits, and a backwater on a stream. Egg masses of this species are attached to aquatic vegetation (Wright and Wright 1949); thus Wood Frogs are most likely to spawn in standing water where suitable vegetation may be found. Spawning had apparently been completed before the 1976 study was initiated in mid-June. This species spawns as early as March in the southern portion of its range but as late as July in the Northwest Territories (Wright and Wright 1949). Within the study area metamorphosis occurred as early as 30 June and was complete by early August. The period during which metamorphosis occurred within the study area was exceptionally short. Metamorphosis elsewhere may occur from late May to mid-September (Wright and Wright 1949) and overwintering of tadpoles may occur at northern latitudes (Bleakney 1954).

Wood Frogs metamorphose at a size of 14–22 mm head-body length (Wright and Wright 1949). Postmetamorphic individuals in the present study ranged from 14.4 to 18.7 mm ($\bar{x}$ = 17.2, N = 18) and from 18.2 to 24.0 mm ($\bar{x}$ = 20.5, N = 12) by late August. Yearlings ranged from 20.4 to 31.0 mm ($\bar{x}$ = 25.4, N = 13) in late June and thus can be readily distinguished from young-of-the-year. Yearlings apparently do not spawn, as frogs of this size were not found in breeding aggregations. The length of spawning individuals ranges from 29 to 50 mm for males and 34 to 56 for females throughout the range of this species (Wright and Wright 1949). Individuals of this size within the study area are almost certainly two or more years old. Schueler (1973) also found that frogs of this species did not breed until they were two or more years old.

Dispersal of post-spawning adults away from the spawning sites occurs but some adults may be encountered near the margins of water bodies throughout the summer. Young-of-the-year also leave the spawning sites shortly after metamorphosis and only small numbers were encountered at these sites during late August. Wood Frogs are terrestrial and are occasionally found far from water in moist wooded areas. They are known to overwinter under leaf litter (Wright and Wright 1949; Hodge 1976) and under logs or stumps.

Boreal Chorus Frog

The Boreal Chorus Frog was seen at seven of the study sites and spawned at three of these. This species spawned in two of the borrow pits studied and in one natural pond. The eggs are laid in small loose clusters attached to vegetation, frequently in temporary ponds (Wright and Wright 1949). Spawning within the study area had been completed prior to 12 June 1976. Spawning is known to occur as early as late March in Indiana (Wright and Wright 1949), and as early as late April at Lake Wabamun, Alberta. Calling individuals have been heard as early as 3 April (1976) along the Red Deer River near Innisfail (52°N) (personal observations W. R.). Spawning was observed in the northwestern quarter of Alberta in late May of 1976 and likely occurred within the study area at that time. Metamorphosis occurred as early as 24 July and was completed shortly after 3 August. As with the Wood Frog, metamorphosis of this species occurred within a short period. Boreal Chorus Frogs throughout their range metamorphose at lengths of 7.5–13.0 mm (Wright and Wright 1949). Postmetamorphic individuals measured during the present study were much larger, 12.6–14.8 mm ($\bar{x}$ = 13.7, N = 14). Other northern Alberta specimens (N = 18, UAMZ collection) averaged 12.7 mm at, or shortly after, metamorphosis. The relatively large size of Boreal Chorus Frogs at the time of metamorphosis may be the result of development at low temperatures as is true for many poikilotherms (Ray 1961). The size at which young-of-the-year overwinter may be a critical factor affecting their ability to persist during periods of stress. Larger individuals may be more successful in this regard. Yearlings in a number of northern Alberta collections ranged from 15.9 to 17.3 mm during May. Spawning adults, taken from breeding aggregations, in Northern Alberta ranged from 19.3 to 28.2 mm ($\bar{x}$ = 23.0, N = 28). The size of spawning individuals throughout the range of this species ranges from 21 to 32 mm for

males and 20.0 to 37.5 mm for females (Wright and Wright 1949) indicating that individuals within the study area probably do not spawn until they are two or more years old. It is of interest that Matthews (1971) reports that marked individuals in a montane population do not breed until their fourth summer. Boreal Chorus Frogs are known to overwinter in Alberta by burrowing under decaying stumps and into anthills (personal observations W. R.).

Canadian Toad

The Canadian Toad was present at nine of the study sites during 1976 and spawned at seven of these. This species utilized the widest variety of spawning habitats including natural ponds, borrow pits, streams, and lake margins. The eggs of Canadian Toads are laid in long strings and may or may not be associated with vegetation (personal observations W. R.). The long strings of eggs may be less subject to displacement by moving water than the attached spherical or subspherical egg masses of frogs and thus facilitate spawning in waters with a slight current, wave action, and no vegetation. This increases the variety of spawning habitats available to the species; however, egg and tadpole mortality may be higher owing to predation and displacement by running water. The fecundity of Canadian Toads (3354–5842 eggs, N = 3 (V. L. unpublished data)) is higher than that of Wood Frogs ($\bar{x}$ = 777 eggs (Herreid and Kinney 1966)) and Chorus Frogs ($\bar{x}$ = 597 eggs (Whitaker 1971)), which may compensate for the mortality arising in the wide variety of spawning habitats utilized. These strings are also adaptive as some eggs will usually remain submerged if the water level recedes. Spawning within the study area had apparently been completed prior to 12 June. Spawning commenced during May along the Red Deer River in 1976 and had occurred into mid-June at the same site in previous years. Within the study area metamorphosis occurred as early as 25 June and continued until early July. The developmental time for this species appears to be unknown. Postmetamorphic individuals of this species range from 9.0 to 13.5 mm in head-body length (Wright and Wright 1949). Individuals sampled during the present study ranged from 11.9 to 13.2 mm ($\bar{x}$ = 12.4, N = 11) and had attained head-body lengths of 19.3–28.0 mm ($\bar{x}$ = 24.8, N = 10) by late August. The smallest yearling found in late June was 22.0 mm long; thus yearlings are readily distinguishable from young-of-the-year. Spawning individuals of this species range from 58 to 68 mm for males and 56 to 80 mm for females (Wright and Wright 1949); it is unlikely that individuals of this species within the study area spawn until they are two or more years old.

Dispersal of adults from spawning sites occurs soon after spawning but individuals may be found along the margins of these sites throughout the summer. Young-of-the-year toads are often found in high numbers along the margins of spawning areas throughout the summer. Lillywhite and Wassersug (1974) regard the aggregating behavior of young-of-the-year Boreal Toads (*Bufo boreas*) as a retained larval characteristic. Young-of-the-year Canadian Toads were abundant along the Red Deer River (a spawning site) in early September of 1976 but were absent after mid-September, probably having buried themselves in suitable substrate for overwintering.

Habitats and Population Densities

Nine habitat types were identified within 17 study sites. These are ranked in order of decreasing wetness as follows: (1) water, (2) sedge (*Carex* spp.) fen, (3) grass (Graminae) meadows, (4) willow (*Salix* spp.) bog, (5) Trembling Aspen (*Populus tremuloides*) forest, (6) Black Spruce (*Picea mariana*), (7) White Spruce (*Pica glauca*), (8) upland mixed wood (*Populus tremuloides, Picea mariana, P. glauca*), (9) Jack Pine (*Pinus banksiana*).

Because visits to each site were equally divided between mornings and afternoons and proportionately between cool and warm days, any biases in the number of amphibians observed resulting from these factors were minimized. In fact 28.6% of the amphibians were counted on cool mornings (23.7% of the visits) and 14.4% were seen on cool afternoons (14.8%); 34.7% were seen on warm mornings (33.1%), and 22.3% were seen on warm afternoons (28.4%).

Wood Frog

The extent to which each habitat type was utilized by each age class of the Wood Frog during May–August of 1977 is shown in Figure 2. Wood Frogs were most frequently found in

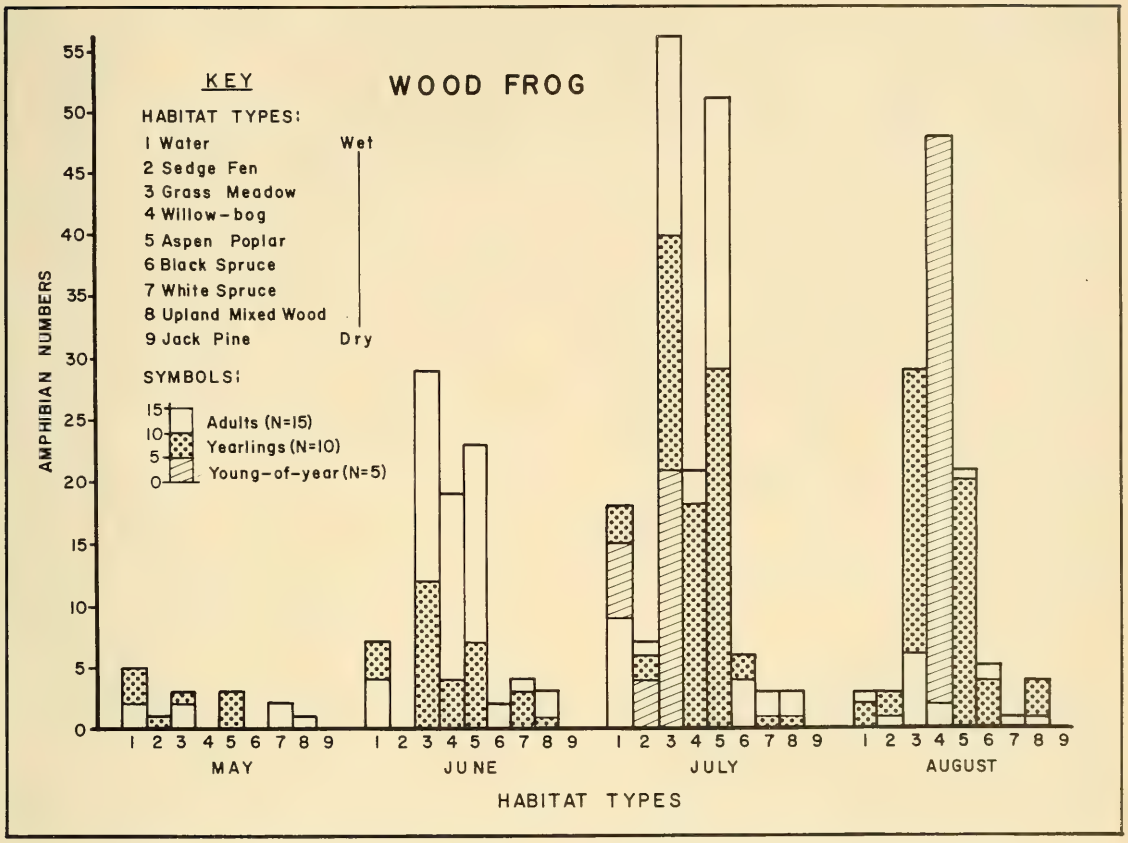

FIGURE 2. Habitat utilization by Wood Frogs in northeastern Alberta during May–August 1977.

grass meadows, willow bogs, and aspen poplar habitat, which are the most moist terrestrial habitats available. Heatewole (1961) regards the Wood Frog as a forest-dwelling species and suggests that the shade provided by trees is an important factor in determining habitat selection. He demonstrated experimentally that substrate structure and substrate moisture are important factors governing the selection of microhabitat. Bellis (1962) states that Wood Frogs are restricted to forested areas, particularly lowland bogs. Shelford (1913) demonstrated that Wood Frogs prefer an environment with moist air. Marshall and Buell (1955) found that in exposed areas with sparse Wood Frog populations the vapor pressure deficit was higher than in shaded tamarack (*Larix larcinia*) habitat with a dense Wood Frog population. It thus appears that moisture content of both the substrate and air are important factors in determining the suitability of habitat types for Wood Frogs. Tall grasses, willows, and aspen poplars growing in moist soil in low-lying areas provide a favorable environment for Wood Frogs within the study area, while much of the forest habitat, especially Jack Pine area, is too dry with respect to substrate moisture and perhaps the humidity of the air.

Heatwole (1961) suggests that the Wood Frog is less terrestrial than previously thought (see Wright and Wright 1949) and points out that its association with woods and damp leaf litter occurs after woodland ponds dry up. Our study sites were associated with more permanent bodies of water. Wood Frogs were rarely found at distances greater than 100 m from a water body and the mean distance for all age classes during each month was less than 50 m. Bellis

(1962) regards the Wood Frog as intermediate between aquatic and terrestrial anurans in its ability to withstand body water loss. Only large Wood Frogs are found in dry habitats and it is probably the large individuals that emigrate and colonize new areas (Bellis 1962). We also noted that larger Wood Frogs tended to be further from water, perhaps owing to their greater ability to tolerate body water loss.

During 1977, 646 Wood Frogs were counted. Population densities of this species ranged from 0.0 to 19.6 individuals (yearlings or older) per 1000 m^2 (Table 1). The highest population density for this species (19.6 adults per 1000 m^2) was found in an area with a mixture of grasses, willow, and aspen poplar. These plant communities are frequently found individually, mixed or intergrading with one another adjacent to water bodies. Bellis (1961) found maximum densities of about 17 individuals per 1000 m^2 in Tamarack and Calla Lily (*Calla palustris*) habitat.

Boreal Chorus Frog

Boreal Chorus Frogs were most frequently found near the water margin or in shallow water amongst vegetation (Figure 3). Too few yearlings or adults were found to determine what, if any, habitat type is preferred. Whitaker (1971) regards the Chorus Frog as a woodland species that occurs most frequently near water, while Stebbins (1954) notes that in the west this species seems to be primarily an inhabitant of open moist grasslands. Kramer (1974) found that the home ranges of Chorus Frogs contained breeding pools and that most frogs remained within 100 m of these pools throughout the summer. In Alberta the Boreal Chorus Frog is known from the prairies, aspen parkland, and boreal forest regions (UAMZ collections), but always near water. It is the most widespread amphibian species within Alberta and persists in a wide variety of moist habitat types providing that at least temporary ponds are available for spawning and for development of the tadpoles.

Boreal Chorus Frogs were found closer to water on the average than the other anuran species present. Adults and young-of-the-year were found at a mean distance of less than 30 m from water during all months. During June of 1977 nonbreeding individuals were found at a mean distance of 54 m from the water margin. This may be the result of their being found close to their overwintering sites. Unlike breeding individuals they probably do not move immediately to water bodies after emergence in the spring. During July and August most individuals of all age classes were found within 20 m of the water margins. Kramer (1973) notes that while a few individuals may be found over 200 m from breeding pools, most are found within 100 m. Individuals may be found buried under leaf litter during the day (Kramer 1973). This may serve as protection against diurnal predators and desiccation. These observations may indicate that this small species is more prone to desiccation than are the larger species.

During 1977, 148 Boreal Chorus Frogs were counted. Insufficient data were obtained to determine population densities on most study plots. Two sites yielded adult population densities of 2.3 individuals per 1000 m^2 (Table 1). Kramer (1974) obtained densities of 0.55 adults per 1000 m^2 from a 33-acre (13.4-ha) study area in Indiana. His data probably include most of the adults present; estimates from the present study, on the other hand, are probably conservative owing to the secretive nature of the Boreal Chorus Frog. Larger numbers of the Boreal Chorus Frog are assumed to be present because of the numbers heard calling (but seldom seen) during May and June.

Canadian Toad

The Canadian Toad was found most frequently in grass meadows and willow bogs near

TABLE 1—Densities of amphibians in selected habitat types within the study area. Numbers in parentheses indicate maximum estimates

Habitat types	Density per 1000 m^2		
	Wood Frog	Boreal Chorus Frog	Canadian Toad
Water Sedge Willow Grass Horsetail Poplar	(19.6) 2.83	(2.3) 0.45	(12) 0.83
White Spruce Black Spruce Upland mixed wood	1.08	0.07	0.16
Jack Pine	0	0	0

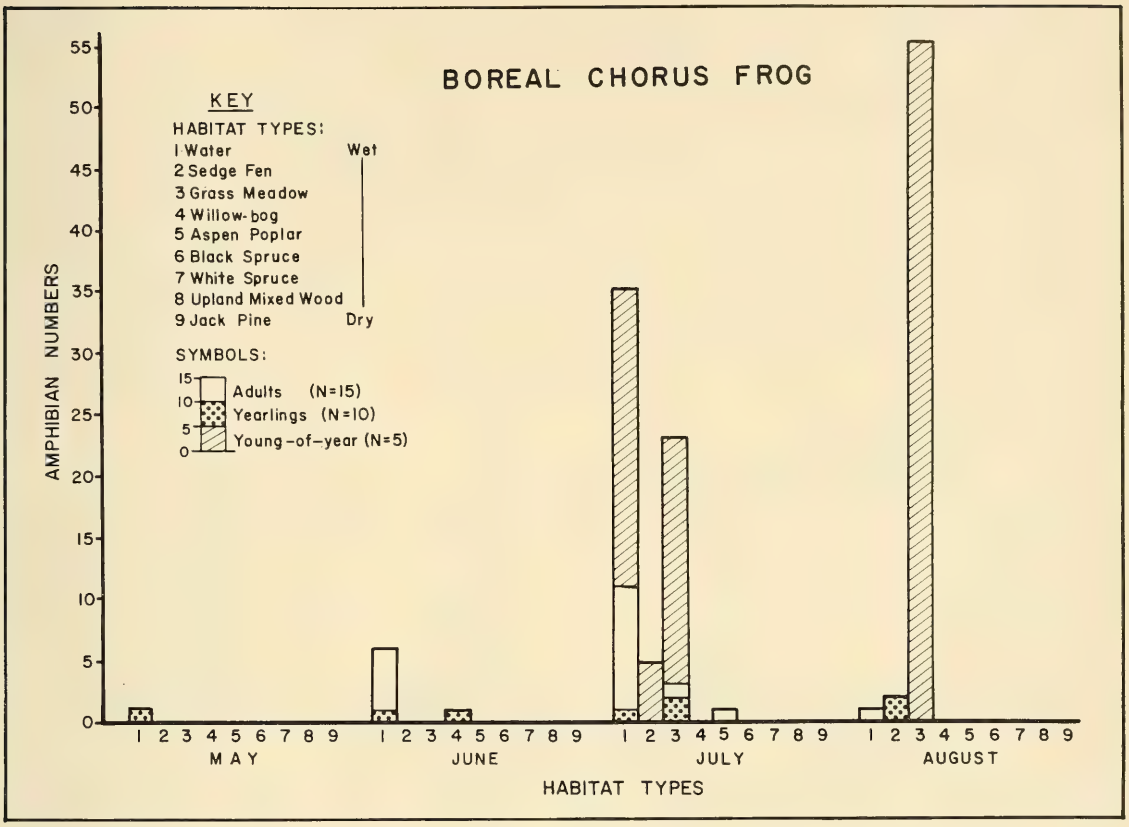

FIGURE 3. Habitat utilization by Boreal Chorus Frogs in northeastern Alberta during May–August 1977.

the water's edge (Figure 4). The Canadian Toad was common at only three of the 17 sites studied. Each of the three sites included poplar forest and grass and two of the three included willows. It is of note that each site was associated with a river or lake rather than a temporary or small permanent pond. Stebbins (1954) states that this species occurs in Transition and lower Boreal life zones (Transition and Canadian life zones of Soper (1964)), in the vicinity of lakes and streams. Underhill (1961) and Henrich (1968) regard the Canadian Toad as a water-adapted species (i.e., less terrestrial than most bufonids) of prairie ponds and lakes. Breckenridge and Tester (1961) found that this was the only toad species present in habitat vegetated by aspen, willows, bluestem (*Andropogon* spp.), and grasses adjacent to a lake. This species is not a forest inhabitant but resides within damp open areas adjacent to water bodies. Its association with lakes and flowing water may be in response to its ability to utilize them as spawning and rearing habitats. In such habitats this species is subject to a minimum of competitive interactions with other anurans which are unable to reproduce successfully there.

Canadian Toads are seldom found far from water. Breckenridge and Tester (1961) found that only a few toads were captured in a trap 63.3 m (200 ft) from the water margin while over 80% of the total capture was within 8 m (25 ft). In June the mean distance from water for all age classes was 60 m; in July and August the mean distance for all age classes was less than 50 m. This difference may have been in response to drying of the terrestrial habitat as the summer progressed. Tamsitt (1962) reports migration of this species to water margins at night, presumably for water imbibition. Breckenridge and Tester (1961) found no such nightly migration,

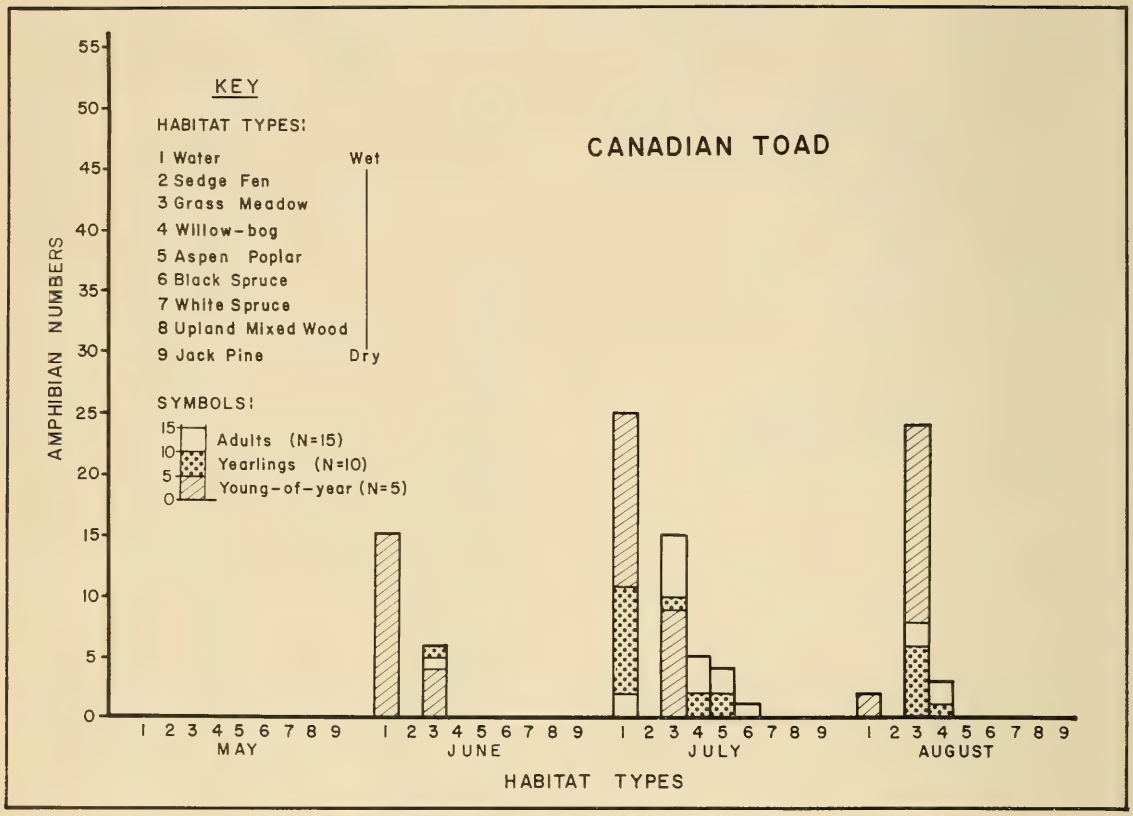

FIGURE 4. Habitat utilization by Canadian Toads in northeastern Alberta during May–August 1977.

however; individuals were seldom found sufficiently far upland that they were in particularly dry habitat.

During 1977, 130 Canadian Toads were counted. Population estimates for this species reached a maximum of 12 adults per 1000 m^2 (Table 1), only slightly over half of the maximum density for Wood Frogs. Kelleher and Tester (1969) found Canadian Toads in much greater abundance. This was probably owing to an abundance of excellent overwintering habitat combined with a lack of competition from other anurans along the margins of a prairie lake.

General Discussion

The relative abundance of the three species found during both years of the study may be misleading. The Wood Frog is certainly widespread and abundant within the study area. This species is the most widely distributed amphibian in North America and occurs further north than any other species. Its adaptations to life in cold regions are summarized by Hodge (1976). Canadian Toads, however, may be much less abundant than the Wood Frog, as 182 of the 207 adult and subadult Canadian Toads seen during 1976 were young-of-the-year. These were found in postmetamorphic aggregations along the margins of spawning sites. In spite of its ability to use the widest variety of spawning habitats (among the three species found here) this species spawned in only 7 of the 24 sites studied compared with 14 sites utilized by the Wood Frog. The Boreal Chorus Frog was heard at or near all of the study sites but spawned in only three of these. Its utilization of temporary ponds and standing bodies of water for spawning sites may reduce the number of potential sites from 24 to 10 for this species. The small size, cryptic coloration, and secretive behavior of Boreal Chorus Frogs

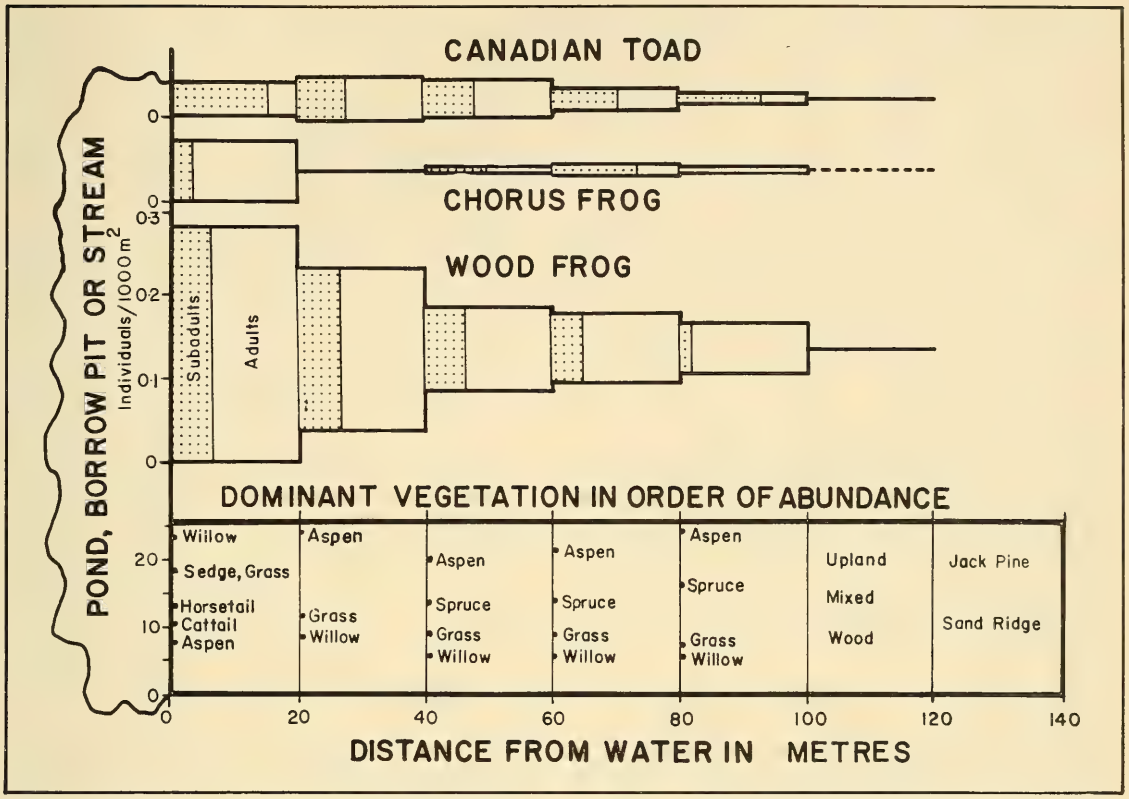

FIGURE 5. Schematic distribution and population density of adult and subadult amphibians in northeastern Alberta in relation to vegetation and water.

make them difficult to see and collect even when they are present in large numbers at spawning sites. Since it is a terrestrial species and frequently hides under logs and stones, it is the most difficult to see of the three species present. This species is probably more abundant than our data indicate.

Leopard Frogs are apparently absent from our study area although they occur further north, probably as glacial relicts. The Red-sided Garter Snake was also not encountered; however, it may occur sporadically, as we have a recent and reliable sight record of one at Point de Roche on the west shore of Lake Claire (J. Kristensen, Department of Zoology, University of Alberta, personal communication).

Thus the known herpetofauna of northeastern Alberta consists of four amphibian species: the Leopard Frog, Wood Frog, Boreal Chorus Frog, and Canadian Toad, and a single reptile, the Red-sided Garter Snake. The Wood Frog is the most abundant and widespread species. The three common amphibian species share a number of life history features. They overwinter in terrestrial sites and spawn in the spring. Larval development is rapid and metamorphosis occurs during the first summer of life. Borrow pits as well as natural ponds appear to be favored as spawning sites over streams and lakes, although lakes are used by toads. Subadults and adults are terrestrial; however, most are found within 50 m of a water body. Highest densities of all species are found in moist habitats, near water vegetated by sedges, grasses, horsetail, willow, and aspen.

The habitat utilization, population density, and distribution of age classes for each species is schematically summarized in Figure 5. The vegetation profile is based on the frequency of occurrence of dominant species within each 20-m segment of the 48 sample plots adjacent to

water. The density values for each amphibian species are based on totals of subadults and adults for all sites and thus represent mean densities. Wood Frogs may be found over 100 m from water; however, most are found within 50 m. Small individuals tend to be found closer to water than large ones. Chorus Frogs are uncommon at distances greater than 20 m from water and none were found further than 100 m from water. Canadian Toads gradually decrease in abundance at distances greater than 40 m from water. No amphibians were found in dry sandy areas with Jack Pine forest habitat.

Acknowledgments

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Caribou Distribution and Group Composition Associated with Construction of the Trans-Alaska Pipeline

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Cameron, Raymond D., Kenneth R. Whitten, Walter T. Smith, and Daniel D. Roby. 1979. Caribou distribution and group composition associated with construction of the Trans-Alaska Pipeline. Canadian Field-Naturalist 93(2): 155–162.

Caribou surveys were conducted periodically along the Trans-Alaska Pipeline haul road on the central Arctic Slope between June and November 1975. Mean calf percentage observed in summer was approximately one-third lower than that obtained from concurrent aerial surveys of both the pipeline corridor and adjacent areas; however, fall means were identical. In both summer and early fall, mean latitudes calculated for groups with and without calves along the haul road were more southerly than for the corresponding group types observed through aerial survey. A more detailed regional comparison of survey data revealed corridor-related abnormalities in Caribou distribution and group composition. No Caribou, or relatively low numbers, were observed in the northernmost segment of the pipeline corridor near Prudhoe Bay, and calf percentages in summer were consistently lower for each of four arbitrarily established regions of the haul road than expected on the basis of aerial survey results; fall calf percentages did not differ appreciably. Mean group size was generally lower along the haul road than for comparable areas to the east and west. Responses of Caribou to the pipeline corridor in general, and of cows and calves in particular, are discussed in relation to inherent avoidance tendencies as modified seasonally by terrain, group dominance, and human activity.

Key Words: Caribou, *Rangifer,* pipeline, disturbance, group composition, Prudhoe Bay, ecological distribution.

The discovery of vast petroleum reserves at Prudhoe Bay in 1968 resulted in construction of the Trans-Alaska Pipeline, designed to transport crude oil to Valdez on the Gulf of Alaska. North of the Yukon River, the pipeline and its associated haul road were to traverse the ranges of two major subpopulations of Barren-ground Caribou (*Rangifer tarandus granti*), the Porcupine and Western Arctic herds (Skoog 1968; Hemming 1971), and concern was focused on the potential restriction of Caribou movements.

In 1971 and 1972 K. N. Child (1973, Completion Report, Alaska Cooperative Wildlife Research Unit, University of Alaska), using simulated pipeline and pipeline crossing structures at Prudhoe Bay, attempted to assess the effectiveness of various above-ground designs in permitting free movements of Caribou. The majority of approaching Caribou avoided the simulation and, of the successful crossings, about 3 times as many were by use of ramps than by passage under the structure. This detailed study provided valuable preliminary data but was limited to observations on summer range. Thus, little was known of the seasonality of Caribou responses to pipelines and construction-related human activity. Consequently, a major study was undertaken to evaluate the reactions of Caribou to the Trans-Alaska Pipeline on a seasonal basis and to document any associated shifts in annual movement patterns and range occupancy. To date, this investigation has been largely restricted to the Arctic Slope.

Based on summer and fall surveys in this region between 1969 and 1972, A. Gavin (1973, Report by Atlantic Richfield Company) reported a decline in Caribou numbers from 26 000 to 2500, and he thought these Caribou to be "offshoots" from the Porcupine and Western Arctic herds. Cameron and Whitten (1979), however, have recently identified a third subpopulation of about 5000 Caribou whose range is centered on the pipeline route along the Sagavanirktok River (Figure 1). Seasonal movements are primarily north–south, between calving grounds near the coast and winter range in the northern foothills of the Brooks Range. The identity of this "Central Arctic herd" has apparently been confounded by periodic influx from one or both of the larger adjacent herds, although such outside influence was thought to be minimal during the course of the present

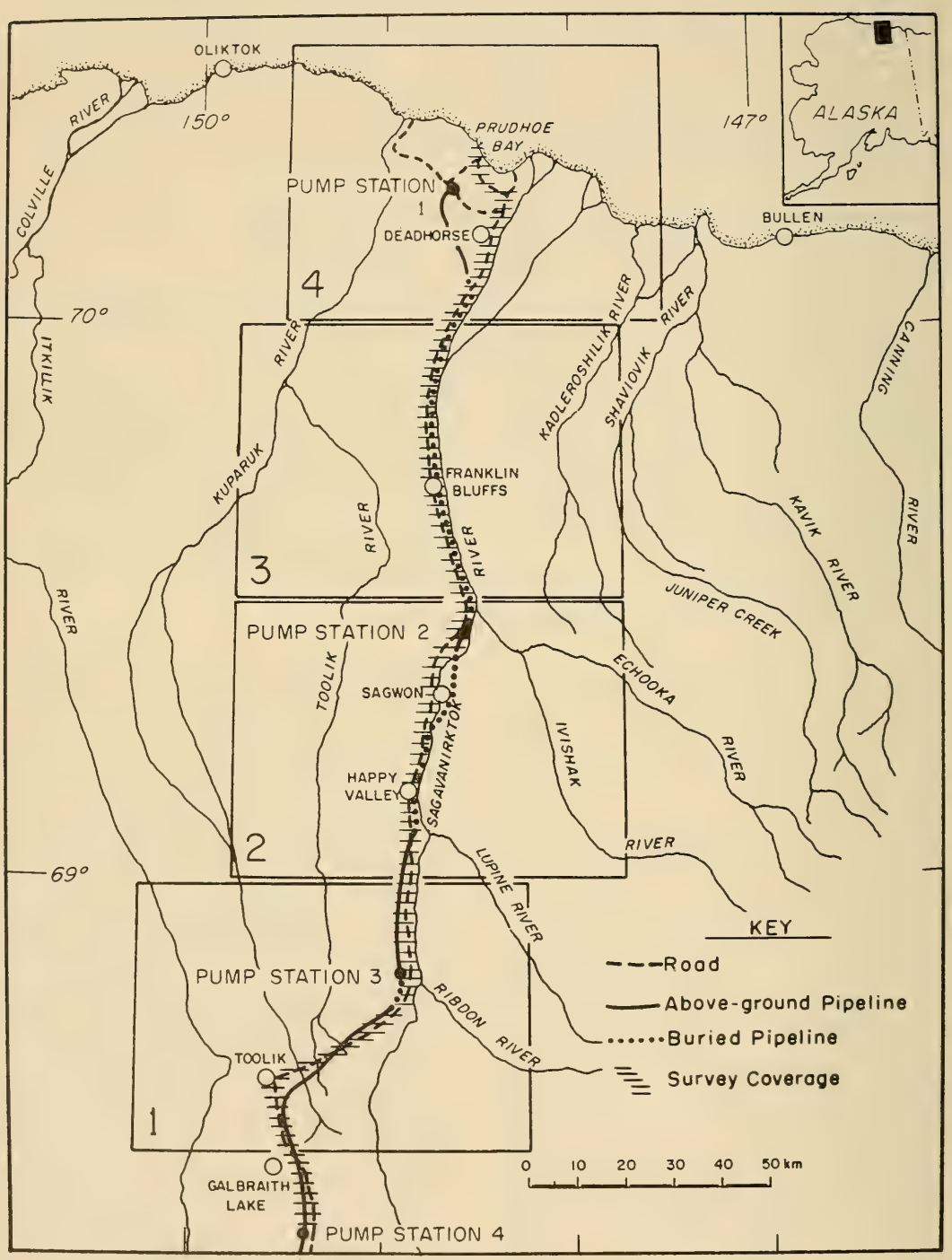

FIGURE 1. Survey coverage along the Trans-Alaska Pipeline corridor and regional boundaries established for comparison of haul road and aerial survey results.

study. This report deals with changes in latitudinal position, group size, and composition of Caribou along the Trans-Alaska Pipeline haul road during summer and fall 1975. These data are compared with similar values obtained through concurrent aerial survey of a larger area extending east and west of the corridor.

The haul road between the Yukon River and Prudhoe Bay was completed in fall 1974, and pipeline construction efforts were near maximum during the major portion of this investigation. The pipeline is 122 cm in diameter and is alternately buried and above ground depending on soil stability; ground clearances of elevated sections range from less than 1 m to a maximum of about 5 m.

Methods

Systematic surveys were conducted from the Trans-Alaska Pipeline haul road between June and November 1975. Generally these were scheduled twice-monthly, each survey consisting of two complete trips over the 263-km distance between Pump Station 4 and Prudhoe Bay (Figure 1). As only half of the route could be covered in 1 d, most surveys required 4 d for completion. Owing to inclement weather, survey components were not necessarily on consecutive days, but an attempt was made to minimize the time interval for each series. Inclusive dates are given in Table 1.

A pickup truck, generally with one driver/observer, was used for all road surveys. Speeds were adjusted to 40–65 km/h, depending on visibility, to provide reasonably constant perceptibility of Caribou for an estimated 1.5 km on either side of the haul road. Only Caribou observed initially with the naked eye were recorded, but binoculars and spotting scope were used as required to obtain additional information. Pertinent data recorded for each Caribou sighting included the following:

Location — road distance from a known point;
Number of Caribou per group (defined arbitrarily as a single Caribou, or two or more Caribou separated by less than an estimated 300 m);
Group composition —
calf — less than 1 yr old,
yearling — more than 1 yr old but less than 2 yr old,
cow — female more than 2 yr of age,
bull — male more than 2 yr of age,
adult — more than 1 yr old, sex unknown,
unknown — unclassified as to sex or age.

TABLE 1—Changes in Caribou numbers and mean group composition along the Trans-Alaska Pipeline haul road, June–November 1975

Survey dates	Total number of caribou observed	Total classified			Groups with calves			Groups without calves	
		Number of caribou[a]	Bulls, %	Calves, %	Number of caribou[b]	Bulls, %	Calves, %	Number of caribou[c]	Bulls, %
June 11–18	91	79	66	0	0	0	0	79	66
June 24–July 2	361	342	86	3	19	8	21	323	92
July 10–17	677	677	52	32	499	35	43	178	100
July 24–August 2	136	136	98	1	5	60	20	131	100
August 7–13	273	273	77	7	57	2	32	216	97
August 20–28	156	149	92	1	11	19	18	138	98
September 3–6	202	200	83	3	23	30	26	177	90
Summer mean[d]			65	13(21)		31	40(35)		94
September 20–28	602	416	44	17	333	30	23	83	99
October 24–28	54	31	36	24	25	26	30	6	80
November 5–10	176	37	49	10	19	25	19	18	74
November 19–25	92	36	43	11	25	30	17	11	73
Fall mean[d]			43	17(17)		29	23(21)		92

[a]Total caribou in groups with no "unknowns" (see Methods).
[b]Total caribou in groups with one or more calves present.
[c]Total caribou in groups with no calves.
[d]Aggregate percentages; those in parentheses were determined from aerial surveys (Cameron and Whitten 1979).

Road locations were converted to their latitudinal equivalents using 1:63 360 scale maps of USGS Topography Series. For each survey series a mean latitudinal position of Caribou was calculated as described by Cameron and Whitten (1979).

Results and Discussion

Caribou Numbers and Group Composition

Numbers and group composition of Caribou observed from the haul road during each survey period are given in Table 1. Groups with one or more "unknowns" (see Methods) were excluded from composition calculations. Ninety-eight percent of the total Caribou sighted during summer were successfully classified. During fall, however, bright sun and snow frequently created distortion which precluded classification at distances greater than about 400 m, and entire groups were recorded as unknowns; the proportion classified decreased to 56%. Cows and yearlings were often difficult to distinguish, and many such individuals were classified as "adults" (see Methods) when more specific identification was impossible. Calves, however, were relatively easy to recognize and reported percentages are thought to be very reliable. Similarly, identification of bulls was rarely in question.

During summer 13% of total Caribou observed from the haul road were calves, compared with a corresponding value of 21% obtained by systematic aerial survey of a larger area roughly centered on the pipeline route (Table 1). In contrast, a mean of 17% calves was observed in fall during both road and aerial surveys, indicating that a representative portion of the herd was present along the corridor. Within each season, calf percentages for groups with calves were similar for road and aerial observations (Table 1). It can be calculated from the summer road data in Table 1, however, that the number of Caribou observed in groups with calves averaged 33% of the total classified, whereas 60% of Caribou classified by air were observed in groups with calves (see Cameron and Whitten 1979); respective mean values for fall were similar at 77 and 81%. In addition, observations from the haul road indicate that bulls were present in low numbers in groups with calves but consistently predominated in groups without calves, and the percentages did not differ appreciably with season for either group type (Table 1). Clearly then, the low proportion of calves recorded during haul road surveys in summer was due primarily to a local reduction in the relative number and/or size (see below) of groups with calves rather than a lower percentage of calves in such groups.

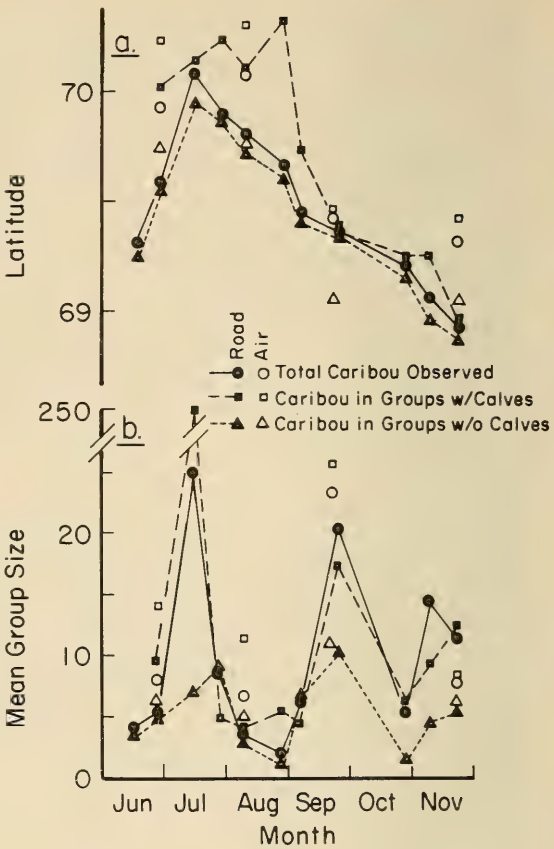

FIGURE 2. Seasonal changes in mean latitudinal position and mean group size of Caribou along the haul road and a comparison with corresponding results from aerial surveys.

Latitudinal Movements

Changes in mean latitudinal position of Caribou along the haul road are depicted in Figure 2a. Throughout summer, groups with calves remained farther north than groups without calves. A similar trend was obtained from concurrent aerial surveys (Cameron and Whitten 1979), and these results are plotted for comparison. Thus, the more northerly location of the mean shown for aggregate sightings by air

is partially attributable to a greater proportion of groups with calves (see previous section) because they tend to occupy higher latitudes. Positions determined by aerial survey for groups both with and without calves, however, were also farther north than those calculated from road survey observations. Corresponding means did not differ appreciably in September, but the same general trend was again apparent in November (Figure 2a), despite the fact that no overall differences in calf percentage were observed (Table 1). Thus, dissimilar composition does not fully account for the more southerly distribution of Caribou along the pipeline corridor. Rather, local abnormalities are indicated.

Group Size

Two distinct peaks in group size are shown in Figure 2b for haul road observations, one in mid-July during post-calving aggregation and another in September just prior to the rut. Except for late July and early September, the mean size of groups with calves was greater than that for groups without calves. A further comparison of these means with those determined from aerial surveys indicates that in June, August, and September the size of corresponding group types was higher for aerial than for haul road surveys. A valid comparison is not possible for November because of the extremely small sample size (Table 1). Because the same criteria for group identification were used in both survey procedures (see Methods), these data suggest avoidance of the area by larger groups, group fragmentation, and/or a decreased tendency for group coalescence near the pipeline corridor.

Differences in Regional Distribution and Group Composition

To permit a more accurate assessment of latitudinal distribution and group composition of Caribou, four regions were delineated along the pipeline corridor for direct comparison of aerial and road survey observations. These regions were centered on the corridor, and each was bounded arbitrarily by ½ degree of latitude and 2 degrees of longitude (Figure 1). The regional distribution of total Caribou observations for both aerial and road surveys is shown in Figure 3, and applicable calf percentages are presented in Table 2. It was assumed that aerial survey results reflected the true distribution of Caribou among the four regions and provided representative data on composition within each region. Corresponding data from the haul road, obtained concurrently, are compared with these "expected" values. As sample sizes were frequently low, statistical analysis of differences in group composition was not feasible, but some overall and regional trends are apparent.

Figure 3 demonstrates a distinct north–south gradient in regional density of Caribou for both

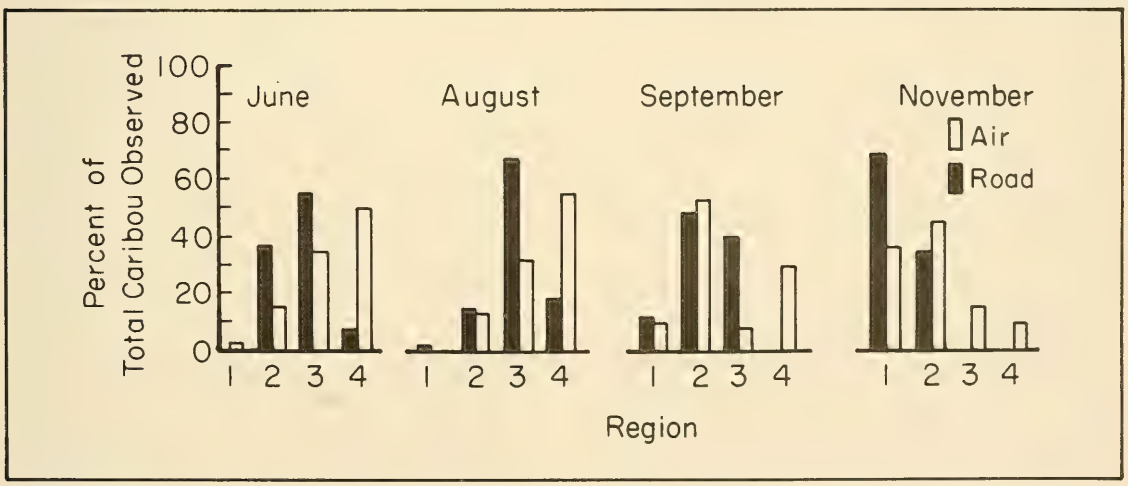

FIGURE 3. Regional distribution of Caribou (see Figure 1) determined from corresponding aerial and haul road surveys.

TABLE 2—Regional comparison of calf percentages determined from corresponding aerial and haul road surveys, June–November 1975

Month[a]	Survey method[a]	Region 1 Number of caribou[b]	Region 1 Calves, %	Region 2 Number of caribou[b]	Region 2 Calves %	Region 3 Number of caribou[b]	Region 3 Calves, %	Region 4 Number of caribou[b]	Region 4 Calves, %
June	Air	4	0	65	2	159	10	231	27
	Road	0	—	121	0	195	4	26	12
August	Air	0	—	49	0	122	9	200	34
	Road	4	0	37	0	183	3	49	27
September	Air	32	0	174	21	18	22	99	20
	Road	59	6	125	9	232	25	0	—
November	Air	238	7	256	17	101	27	57	44
	Road	36	11	0	—	0	—	0	—

[a]Aerial surveys (Cameron and Whitten 1979) or haul road surveys within the regions shown in Figure 1.
[b]Number of caribou classified, i.e., total caribou in groups with no "unknowns" (see Methods).

June and August, with aerial sightings in region 4 representing 50 and 55% of the total, respectively. In contrast, the majority of haul road observations during summer were in region 3, and relatively few Caribou were observed near the coast. Calf percentages for regions 3 and 4 of the haul road were appreciably lower than expected, while few calves were noted in regions 1 and 2 from either road or air (Table 2). For all regions combined, calf percentages determined from aerial and haul road surveys, respectively, were 17 and 3 in June, and 20 and 7 in August. Thus, the more southerly distribution of Caribou within the pipeline corridor in summer was due in part to a general avoidance of northern sections near Prudhoe Bay. In addition, aggregate and regional calf percentages were consistently lower than the expected values, indicating a disproportionate avoidance of the pipeline corridor by groups with calves. The resulting preponderance of bulls (i.e., groups without calves), by virtue of their latitudinal preference (Figure 2a), contributed further to a southward displacement of Caribou along the haul road.

By late September a southward movement of Caribou had occurred. Approximately half of the total sightings from both air and haul road were in region 2, but no Caribou were observed along the corridor in region 4 where nearly one-third of the total was observed during aerial surveys (Figure 3). During both aerial and road surveys the majority of Caribou were found in groups with calves (Table 1), and mean group size increased (Figure 2b) as pre-rut aggregations formed. Although aerial observations indicated that groups without calves remained substantially farther south (Figure 2a), such differences are of little quantitative importance as these Caribou represented less than 10% of total sightings. Regional differences in calf percentage demonstrate no consistent trend (Table 2), but combining data for regions 1, 2, and 3 results in an estimated 17% calves for both air and road surveys. Thus, in September a strong avoidance of the Prudhoe Bay area is indicated, but sightings of Caribou elsewhere along the haul road appear to reflect overall herd composition, and disproportionate avoidance by groups with calves was not apparent. In November aerial surveys established that fewer Caribou were occupying coastal areas. Most Caribou within the corridor were in region 1, and none were observed in regions 3 and 4 (Figure 3). Total haul road sightings in November were among the lowest recorded (Table 1), and any conclusions regarding differences in calf composition would be equivocal because of small sample size. Nevertheless, combined data for fall again indicate that a more representative portion of the herd approached and was observed from the haul road, although continued avoidance of northern areas is indicated.

Relatively low numbers of Caribou near the haul road in region 4 during summer and fall may partially explain the small group size observed within the pipeline corridor (Figure 2b). Groups with calves observed along the coast

by air were generally larger than comparable inland groups, and their avoidance of the haul road area would tend to depress the calculated mean irrespective of other influences on group size. Groups without calves, however, exhibited a similar decrease in summer and a corridor-related reduction in group size remains suspect.

Avoidance Behavior of Caribou

Avoidance of the Prudhoe Bay area was noted throughout the course of this study. The coastal region near Prudhoe Bay, recently the site of increased construction and exploration activity, was previously a portion of the calving grounds for the Central Arctic herd. As late as 1972 K. N. Child (1973, *op. cit.*) and A. Gavin (1973, *op. cit.*) reported calving within or immediately adjacent to the Prudhoe Bay complex. With facilities expansion and continued human activity over the past 3 or 4 yr, local occupancy by Caribou has generally decreased, and in 1975 we observed no neo-natal calves from this northernmost section of the haul road. The area was also previously invaded by Caribou during annual post-calving movements along the coast (Cameron and Whitten 1979) and during oscillatory movements to and from the coast in response to changing insect density (Child 1973, *op. cit.*; White et al. 1975). Evidence for these occurrences is still visible as Caribou trail systems and, although movements within the Prudhoe complex are still detectable, they are now mere remnants of past activities. Post-calving and insect-induced movements, however, still occur elsewhere along the coast between the Colville and Canning rivers, indicating avoidance of a specific portion of summer range with continued occupancy of adjacent regions. Disturbance-related abandonment of range is thought to be a gradual process, occurring with increasing avoidance of adverse stimuli (Klein 1971; Calef 1974), and the recent history of changing Caribou occupancy near Prudhoe Bay appears to reflect this pattern.

In summer, avoidance of the pipeline corridor was primarily by cows and calves. Cows are most sensitive to unusual stimuli just before parturition or during the early stages of labor (Lent 1966), but the present results suggest that heightened sensitivity extends through the first 2 or 3 months post-partum. Other reports indicate that cows and young calves are more easily alarmed by, and more likely to flee from, a potential threat than are male Caribou, barren cows, or cows with older calves (de Vos 1960; Lent 1966; Bergerud 1974). Loud noises, unless associated with moving objects, do not generally alarm Caribou which perceive and identify adverse stimuli through visual and olfactory means (Bergerud 1974). Cows with young calves, however, consistently take flight from distant stimuli, using visual analysis without verification by scent (Bergerud 1974). Bergerud (1974) and Lent (1966) reported that alert posture assumed by individuals within a group did not generally induce group flight unless cows and neo-natal calves were present. Also, we noted that cow-calf pairs on the calving grounds were difficult to approach on foot to within 400 m.

Because of the importance of visual stimuli, local terrain relief may influence the degree of avoidance of the pipeline corridor. North of Pump Station 2 the haul raod traverses more than 100 km of continuous coastal plain (see Figure 1) which is preferred summer range for the Central Arctic herd. Construction activity is frequently visible for 20 km or more, and the greater inherent sensitivity of cows and calves together with greater visibility provided by flat terrain may account for the observed avoidance of the haul road during summer. Bulls do not appear to be as sensitive to local human activity; however, since the mean latitude of groups without calves (i.e., principally bulls) was also displaced southward some evidence exists for low-level avoidance of northern areas.

Avoidance of the Prudhoe Bay complex continued during fall, and most Caribou were observed farther inland. In September and October groups along the haul road were well mixed sexually, and cow-calf avoidance of the pipeline corridor appears to have diminished. This may be partially a result of a change in group dominance associated with breeding; rutting bulls clearly influence group activity (Bergerud 1973; Cameron and Whitten, unpublished observations; Roby 1978) and may alter the "normal" avoidance behavior of cow-calf pairs. Perhaps more importantly, the advanced age of calves may have reduced the sensitivity of maternal cows to human disturbance.

Continued study is necessary to assess the long-term responses of Caribou to oil development in the Arctic. Sustained exposure of Caribou to these stimuli may increase the degree of avoidance, stabilize it at the current level, or ultimately result in a reversal with subsequent accommodation. Further, it is not known whether this avoidance response, by virtue of its probable influence on free movement, will seriously alter herd productivity. Such are matters for conjecture, and should be addressed by future investigations.

Acknowledgments

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Interesting Vascular Plants from Southeastern Yukon Territory

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Recent vascular plant collections in extreme southeastern Yukon have added considerable data on the flora of the Yukon Territory. This paper reports 19 taxa as new to the Yukon (*Botrychium virginianum* var. *europaeum, Dryopteris spinulosa, Matteuccia struthiopteris* var. *pensylvanica, Agrostis exarata, Cinna latifolia, Muhlenbergia mexicana, Oryzopsis asperifolia, Poa ammophila, Sphenopholis intermedia, Parietaria pensylvanica, Vicia americana, Viola rugulosa, Circaea alpina, Aralia nudicaulis, Osmorhiza depauperata, Castilleja miniata, Anaphalis margaritacea* var. *subalpina, Aster ciliolatus,* and *Bidens cernua*) and 43 taxa as extensions of known ranges into the southeastern Yukon.

Key Words: vascular plants, Yukon Territory, flora, range extensions.

During July of 1977, the senior author, in connection with other work, had the opportunity to collect vascular plants from three sites in extreme southeastern Yukon. Although 214 taxa of vascular plants were collected, the purpose of this paper is to report only new records and major extensions of known ranges for the Yukon Territory.

Field studies were made at one cool spring and two hot springs. The cool spring site, the most intensively collected, was near two terraced tufa deposits at the base of a limestone ridge on the east side of the Coal River. Scalloped terrace-faces on the west side of the pools were covered with a variety of bryophytes and vascular plants (Figure 1). Specimens from poorly drained communities below the two tufa deposits and in surrounding Black Spruce (*Picea mariana*), White Spruce (*P. glauca*), Lodgepole Pine (*Pinus contorta* var. *latifolia*), and Balsam Poplar (*Populus balsamifera*) stands were also collected.

The locations (Figure 2) and elevation of the collection sites, date of collection, collectors' names and collection numbers follow:

1. Cool springs and adjacent areas near the Coal River, 60°09′N, 127°26′W, elevation 650–750 m, 16–19 July 1977, Scotter and T. Ahti 24304–24598.
2. Hot springs and adjacent areas near Larsen Creek, 60°12′N, 125°32′W, elevation 760 m, 20–22 July 1977, Scotter 24599–24756.
3. Hot springs and adjacent areas near the Beaver River, 60°23′N, 125°34′W, elevation 450 m, 22 July 1977, Scotter 24757–25775.

The southeastern Yukon is mostly forested with open stands of Black Spruce, White Spruce, and Lodgepole Pine. Small portions of the area extend above treeline, which occurs at approximately 1200–1350 m asl. The area lies within the Liard and Hyland plateaus and the whole area was covered by at least one advance of Cordilleran ice. For greater details on vegetation and geology of the region readers are referred to Douglas and Norris (1959), Bostock (1948), Gabrielse and Blusson (1969), Rowe (1972), and Oswald and Senyk (1977).

Voucher specimens have been deposited at the Agriculture Canada herbarium (DAO). Unless otherwise indicated, all specimens were determined by Cody. A complete species list of the plants collected is available and may be obtained by contacting the authors.

In the annotated list, voucher numbers follow the species; site numbers are in brackets. Species not previously reported from the Yukon are noted with an asterisk (*). Nomenclature follows Porsild and Cody (1979).

The ecology of springs in northwestern Canada has been little studied except for Liard Hot Springs, British Columbia (Porsild and Crum 1961) and some near Hole-in-the-Wall Lake, Nahanni National Park, Northwest Territories (Arnold 1961). The three springs studied in the Yukon are very different from each other in structure and associated vegetation so that

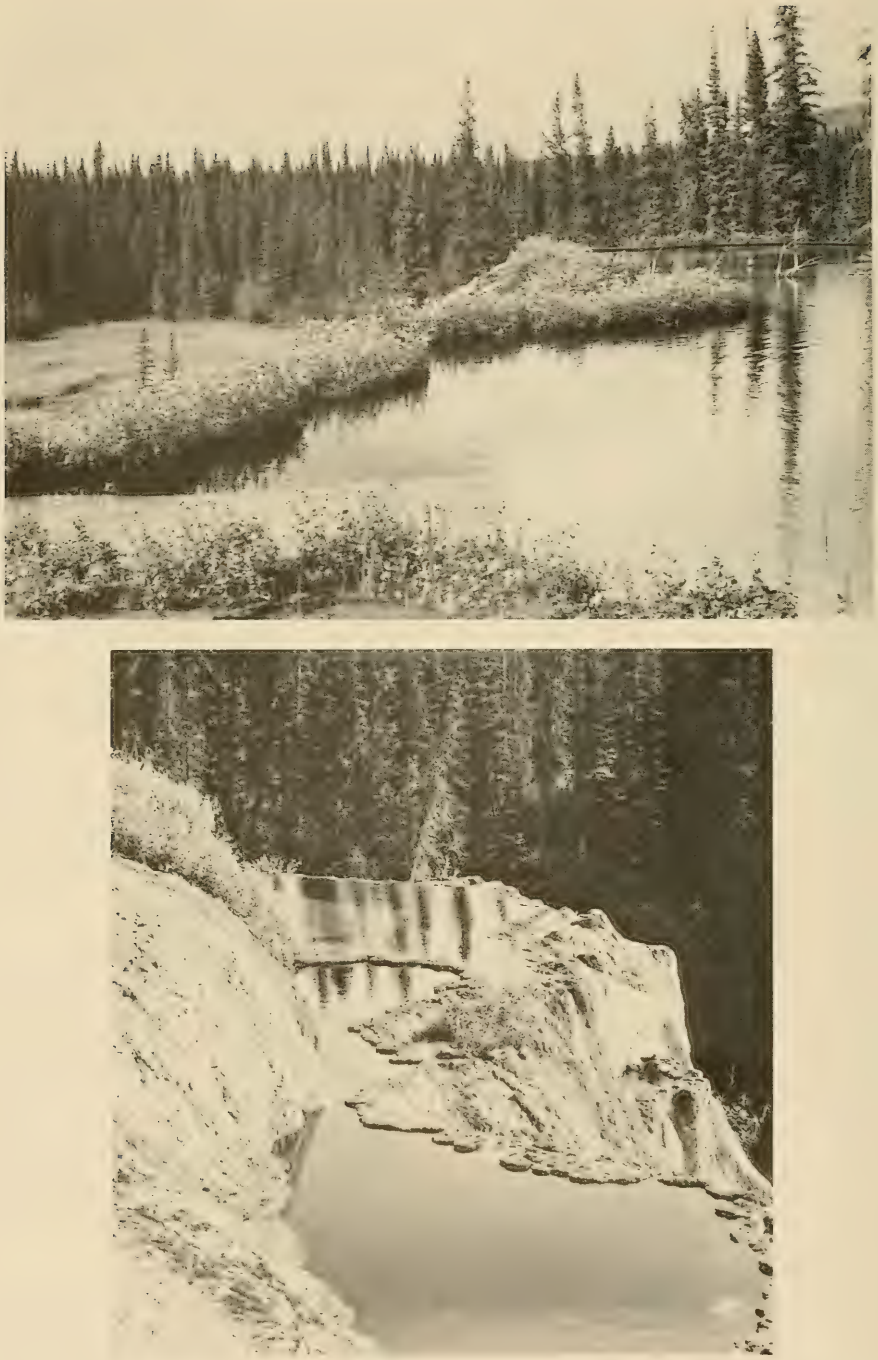

FIGURE 1. The most common plants at the cool spring site growing on top of the tufa terraces were tall White Bog Orchid (*Habenaria dilatata*), Marsh Grass-of-Parnassus (*Parnassia palustris* var. *neogaea*), Meadow Fireweed (*Epilobium glandulosum* var. *adencaulon*), Yellow Monkey Flower (*Mimulus guttatus*), Pink Fleabane (*Erigeron philadelphicus*), Yellow Ragwort (*Senecio pauperculus*), and several species of grasses and sedges. Mats of velvety-green bryophytes covered the sides of the moist tufa terraces.

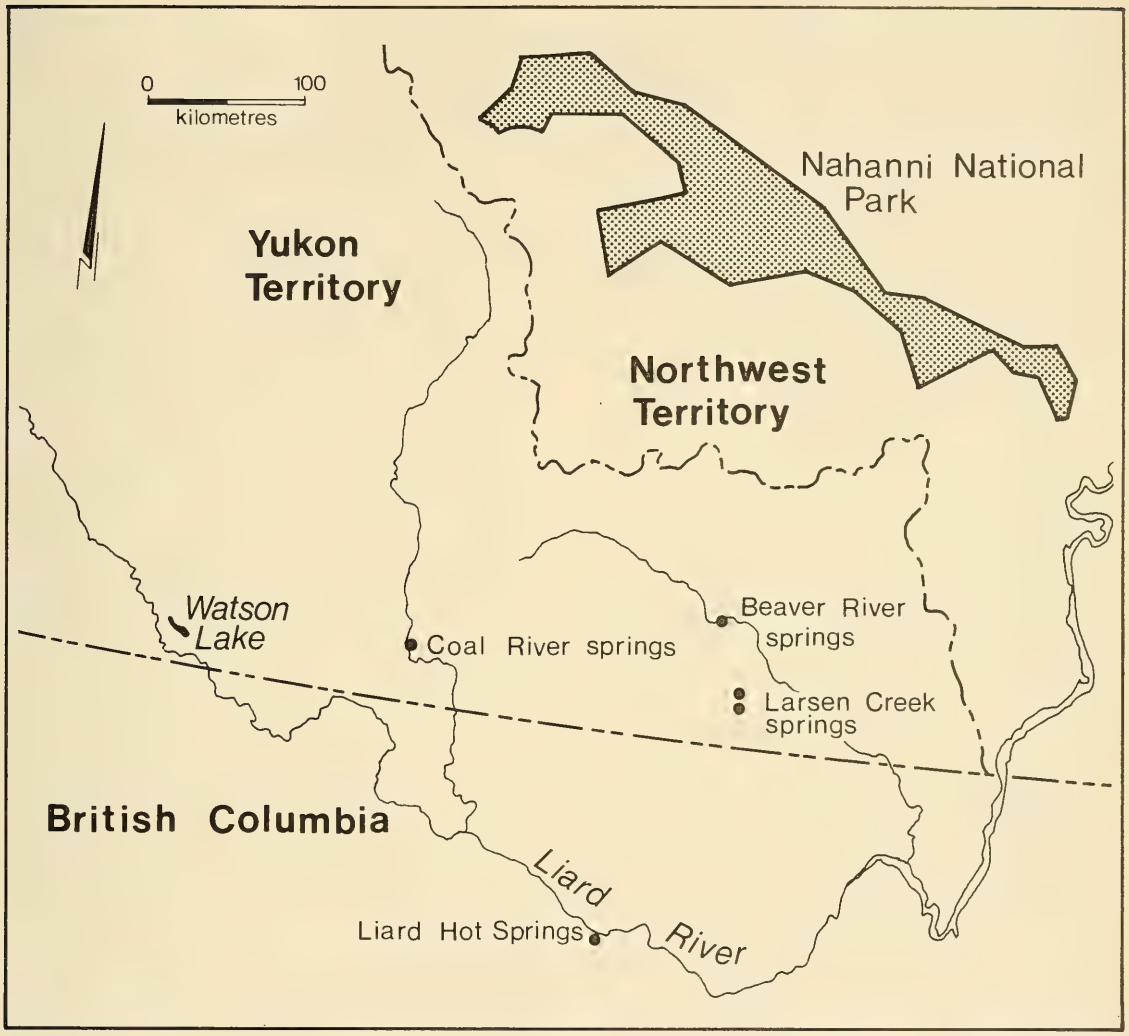

FIGURE 2. Map of the southeastern Yukon and adjacent regions showing the three collection sites in relation to Liard Hot Springs and Nahanni National Park.

generalization on ecology is difficult. The Liard Hot Springs and the springs near the Coal River, however, have a close affinity in both structure and associated vegetation.

**Botrychium virginianum* var. *europaeum* (Rattlesnake Fern). 24475, 24478 (1); 24712, 24673 (2).

Previously known from northern British Columbia (Hultén 1968; Porsild 1951) and several sites in southwestern District of Mackenzie (Cody 1963; Scotter and Cody 1974).

Athyrium filix-femina ssp. *cyclosorum* (Lady Fern). 24473 (1).

This appears to be the second report of this species from the Yukon Territory. Porsild (1951) found *A. filix-femina* ssp. *cyclosorum* at a hot spring site in the Mayo District. In the southwestern District of Mackenzie it is known from only three localities (Jeffrey 1961; Porsild 1961; Scotter and Cody 1974), two of which are hot spring sites.

**Dryopteris spinulosa* (Spinulose Wood Fern). 24468, 24472, 24482 (1).

Rare in the northwestern part of its range. A site in Nahanni National Park, the second site in the District of Mackenzie, is soon to be reported by Cody et al.[3]

**Matteuccia struthiopteris* var. *pensylvanica (Pteritis nodulosa)* (Ostrich Fern). 24764 (3).

According to Hultén (1968), this fern is restricted to small isolated areas in Alaska. In northern British Columbia, Porsild and Crum (1961) reported that it formed dense colonies near and below the springs at Liard Hot Springs. In the southwestern District of Mackenzie it occurs on the flood plain of the Liard River nearly as far downstream as Nahanni Butte (Cody 1963) and on the floodplains of the lower South Nahanni River (Scotter and Cody 1974).

Equisetum hyemale var. *affine* (Scouring Rush). 24743 (2).

According to the map in Hultén (1968), this collection extends the known range to the southeastern Yukon Territory.

Selaginella selaginoides (Spikemoss). 24527 (1); 24639 (2).

These collections of this species in the southeastern Yukon Territory change the position of the delimiting line in Hultén (1968) to include all of the southern Yukon Territory.

× *Agrohordeum macounii* (*Elymus macounii*). 24617 (2).

This hybrid of *Agropyron trachycaulum* and *Hordeum jubatum* was known in the Yukon Territory by Porsild (1951) from only three collections. In the herbarium of the Department of Agriculture at Ottawa (DAO), there are now an additional eight collections. The hybrid is thus of much more frequent occurrence than previously suspected, and may occur wherever the two parents are found growing in close proximity.

**Agrostis exarata*. 24345, 24351, 24358 (1); 24622B (2).

Cody and Porsild (1968) extended the known range of this species from the Pacific Coast to the District of Mackenzie at Tungsten. Scotter and Cody (1974) have since reported additional sites at both hot and cool springs in Nahanni National Park.

Bromus ciliatus (Fringed Brome). 24320, 24332 (1); 24610, 24611 (2).

Hultén (1968) shows only three widely separated Yukon sites on his map. The species is not common in southwestern District of Mackenzie, but Porsild (Porsild and Crum 1961) has collected it at Liard Hot Springs.

**Cinna latifolia* (Wood Reedgrass). 24412 (1).

Cody (1963) reported a number of stations along the lower Liard River, and Porsild and Crum (1961) found it to be occasional in rich mixed aspen and spruce woods at Liard Hot Springs.

Danthonia intermedia (Wild Oat-Grass). 24770 (3).

This collection helps fill in the known distribution of this species between sites in southern Yukon Territory (Porsild 1951, 1966) shown on Hultén's (1968) map, and sites reported by Scotter and Cody (1974) and Cody et al.[3] in Nahanni National Park.

Glyceria striata var. *stricta* (Fowl Manna Grass). 24342, 24416, 24523, 24555 (1); 24625 (2).

Porsild (1951) surmised that this grass would be found in the Yukon Territory because it was already known from central Alaska and the Liard Hot Springs. Hultén (1968) depicted a collection from near Watson Lake (*Calder & Kukkonen 27617* and *Calder & Gillett 26544* [DAO]). The specimens cited above thus represent the second report of this species for the Yukon Territory.

**Muhlenbergia mexicana*. 24629 (2). (det. C. G. Reeder).

Porsild (Porsild and Crum 1961) and Welsh (1974) reported this grass from the Liard Hot Springs.

**Oryzopsis asperifolia* (Mountain-Rice). 24435 (1).

In northern British Columbia, *O. asperifolia* is known from Mile 578 Alaska Highway, 59°38′N, 127°29′W (*Calder & Gillett 25653* [DAO]). In the District of Mackenzie it has recently been reported from Nahanni National Park (Cody et al.[3]), an extension of range to the northwest from the Salt Plains west of Fort Smith (Raup 1936).

Phalaris arundinacea (Reed Canary Grass). 24408 (1).

The map in Hultén (1968) depicts collections from Whitehorse (Porsild 1951) and near Teslin Lake. Additional Yukon Territory specimens at DAO are from Albert Creek, Mile 643.5 Alaska Highway (*Calder & Gillett 26545, Harms 17199*).

**Poa ammophila*. 24596 (1). (det. M. Barkworth).

This is an extension of the known range of some 900 km to the south from the type region at the mouth of the Mackenzie River on the arctic coast of the District of Mackenzie. It is not known to occur between those collections.

Schizachne purpurascens. 24434 (1).

Previous collections in the Yukon Territory were from along the Canol Road (Porsild 1951; Hultén 1968).

[3]Cody, W. J., G. W. Scotter, and S. S. Talbot. Additions to the vascular plant flora of Nahanni National Park, Northwest Territories (*in preparation*).

**Sphenopholis intermedia.* 24314 (1); 24602, 24612, 24740 (2).

Porsild (1951) and Hultén (1968) reported this grass from Liard Hot Springs and Tanana (Manley) Hot Springs in Alaska. Scotter and Cody (1974) reported it from Nahanni National Park and commented on its presence elsewhere in the District of Mackenzie.

Carex atherodes. 24510, 24511 (1).

These collections will move the delimiting line on the map in Hultén (1968) to the east to include the extreme southeastern section of the Yukon Territory.

Carex concinna. 24452 (1).

This collection will move the delimiting line on the map in Hultén (1968) to the east to include the extreme southeastern section of the Yukon Territory.

Juncus balticus var. *littoralis (J. arcticus* spp. *ater, sensu* Hultén 1968) (Wire Rush). 24540 (1).

This collection will move the delimiting line on the map in Hultén (1968) to the east to include the extreme southeastern section of the Yukon Territory.

Allium schoenoprasum var. *sibiricum* (Wild Chives). 24563 (1).

This collection will move the delimiting line on the map in Hultén (1968) to the east to include the extreme southeastern section of the Yukon Territory.

Smilacina trifolia (Three-leaved Solomon's-seal). 24753 (2).

Apparently rare in southeastern Yukon Territory. The single dot on the map in Hultén (1968) is probably based on specimens gathered at Watson Lake by Raup and Correll (Porsild 1974). It was also collected there by *Mitchell 91* and *Gillett 3618* (DAO). Another unreported collection is from the Cassiar Mountains, 60°18′N, 130°18′W, *Poole 27* (DAO).

Goodyera repens (Rattlesnake Plantain). 24437 (1).

According to the map in Hultén (1968), previous collections from the Yukon Territory have all been made west of 130° W longitude.

Salix longistylis (*S. alaxensis* var. *longistylis*). 24584 (1); 24611, 24644, 24662 (2).

These collections will move the delimiting line on the map in Hultén (1968) to the east to include the extreme southeastern section of the Yukon Territory. The species is, as well, based on collections at DAO, much more frequent in the Mackenzie Mountains in the western District of Mackenzie, than indicated on that map.

Salix padophylla. 24518, 24576 (1); 24660 (2).

These collections will move the delimiting line on the map in Hultén (1968) eastwards to include the extreme southeastern section of the Yukon Territory. To the east it has been recorded from several sites in Nahanni National Park (Scotter and Cody 1974).

**Parietaria pensylvanica* (Pellitory). 24725 (2).

The distribution of this species in Canada is quite spotty (Bassett et al. 1974) because of its apparently restricted habitat requirement of cool, moist, shady, rocky situations. Porsild (1961) reported the extension of the known range from central British Columbia north to Liard Hot Springs, and discussed the distribution.

Urtica gracilis (Nettle). 24462 (1); 24732 (2).

Apparently rare in the Yukon Territory. Hultén (1968) indicates collections from the Dawson area, and near the British Columbia border.

Polygonum amphibium var. *stipulaceum* (Water Smartweed). 24413, 24513 (1).

These collections will move the delimiting line on the map in Hultén (1968) eastwards to include the extreme southeastern section of the Yukon Territory.

Minuartia dawsonensis. 24365, 24372, 24592B (1); 24604, 24641 (2).

These collections will move the delimiting line on the map in Hultén (1968) eastwards to include the extreme southeastern part of the Yukon Territory. It is also known from Nahanni National Park (Scotter and Cody 1974).

Silene menziesii. 24483 (1).

On the basis of the distribution map in Hultén (1968), this species appears to have a broken distribution in the northern part of its range. This collection will move the delimiting line on the map in Hultén (1968) to the east to include the extreme southeastern part of the Yukon Territory.

Ranunculus abortivus (Kidneyleaf Buttercup). 24605 (2).

This is apparently a rare species in the Yukon Territory. Hultén (1968) shows only four dots from the south central part of the Territory.

Thalictrum sparsiflorum var. *richardsonii* (Meadow-Rue). 24406, 24551 (1).

These collections, from the extreme southeastern part of the Yukon Territory, are intermediate between the sites on the map in Hultén (1968) and the Liard River sites in southwestern District of Mackenzie reported by Jeffrey (1961).

Amelanchier alnifolia (Saskatoon). 24422, 24594 (1); 24682 (2).

These collections will move the delimiting line on the map in Hultén (1968) eastwards to include the extreme southeastern part of the Yukon Territory.

Dryas drummondii (Yellow Dryad). 24590 (1); 24626 (2).

The collections, from the extreme southeastern part of the Yukon Territory, are from an area inter-

mediate between two areas of distribution outlined by Hultén (1968).

Geum aleppicum var. *strictum* (Avens). 24618, 24731 (2).

Hultén (1968) shows only a single disjunct locality in southwestern Yukon Territory. The main range extends across Canada from the east coast and reaches Nahanni National Park in southwestern District of Mackenzie.

Sanguisorba sitchensis (*S. stipulata, sensu* Hultén (1968)) (Burnet). 24415 (1).

This collection, from the extreme southeastern part of the Yukon Territory, will move the delimiting line on the map in Hultén (1968) to the east and thus include all of the southern Yukon.

Astragalus americanus. 24564 (1).

According to Hultén (1968), previous collections from the Yukon Territory have all come from west of longitude 132°W.

Oxytropis deflexa var. *foliolosa*. 24646 (2).

This collection helps complete our knowledge of the distribution of var. *foliolosa* in the Yukon Territory by extending the delimiting line around the southern population to the extreme southeastern Yukon. The map in Hultén (1968) depicts widely separated northern and southern populations in the Yukon Territory.

**Vicia americana* (Wild Vetch). 24745 (2).

This species occurs as far north in British Columbia as Liard Hot Springs (Porsild and Crum 1961) while in southwestern District of Mackenzie it is found along the Liard River (Jeffrey 1961) and in Nahanni National Park (Scotter and Cody 1974).

Geranium richardsonii. 24747 (2).

Hultén (1968) shows only a few collection sites in central Yukon Territory and the hot springs at Tungsten in the headwaters of the Flat River in the District of Mackenzie. It is also known from Hole-in-the-Wall Lake in Nahanni National Park (Porsild 1961) in the District of Mackenzie.

Viola langsdorffii. 24638, 24726 (2).

Hultén (1968) indicates two inland sites in central and southern Yukon Territory which are remote from the mainly coastal range of the species. The collections cited here represent another site more remote from the main range.

**Viola rugulosa* (Western Canada Violet). 24735 (2).

This is a westward extension of range from sites in the Liard and South Nahanni valleys in southwestern District of Mackenzie reported by Jeffrey (1961) and Scotter and Cody (1974).

**Circaea alpina* (Enchanter's Nightshade). 24758 (3).

This circumpolar species is known from northern British Columbia at Liard Hot Springs (Porsild and Crum 1961), and in the adjacent District of Mackenzie in the headwaters of the Flat River and along the Liard River (Scotter and Cody 1974).

**Aralia nudicaulis* (Wild Sarsaparilla). 24427 (1).

Porsild and Crum (1961) found this species at Liard Hot Springs, while Jeffrey (1961) and Scotter and Cody (1974) reported it from several sites in the southwestern District of Mackenzie.

Cicuta maculata var. *angustifolia* (Water Hemlock). 24739 (2).

Only one other collection is known from the Yukon Territory by the authors: Tatchun River, Mile 117.5 Mayo Highway, *Taylor 4080* (DAO).

**Osmorhiza depauperata (O. obtusa)* (Sweet Cicely). 24479 (1); 24687 (2).

Recorded from adjacent northern British Columbia at Liard Hot Springs by Porsild and Crum (1961), and from the Liard River Valley in southwestern District of Mackenzie by Cody (1963).

Collomia linearis. 24730, 24742 (2).

This is a native North American species which Hultén (1968) considers to be introduced in the Yukon Territory. It seems doubtful that it was introduced to this remote and pristine site. Previous collections, according to Hultén's map, are all west of longitude 135°W.

Scutellaria galericulata var. *pubescens* (Skullcap). 24771A (3).

Previously known from the Yukon Territory only from the vicinity of Mayo (Porsild 1951, 1974; Hultén 1968).

Castilleja caudata. 24565 (1).

This collection extends the known range of this species to the southeast from western and northern Yukon Territory.

**Castilleja miniata* (Red Indian Paint-brush). 24683, 24728 (2).

This is a northward extension of range from north central British Columbia.

Mimulus guttatus (Yellow Monkey-flower). 24306, 24339 (1); 24678 (2).

According to Hultén (1968) and Porsild (1974) this species barely enters the southern part of the Yukon Territory near Whitehorse and Watson Lake. It has been reported from mineral springs in Nahanni National Park (Scotter and Cody 1974). The plant was very abundant at the Coal River springs.

Galium triflorum (Sweet-scented Bedstraw). 24516 (1); 24675 (2).

This species, according to the map in Hultén (1968), barely enters the southern part of the Yukon Territory west of 133°W longitude. Our collections will move the delimiting line eastward to include the extreme southeastern Yukon Territory. In the adjacent District of Mackenzie it is known along the Liard River (Cody 1961; Jeffrey 1961) and in Nahanni National Park (Scotter and Cody 1974); in northern British Columbia it has been found at Liard Hot Springs (Porsild and Crum 1961).

**Anaphalis margaritacea* var. *subalpina* (Pearly Everlasting). 24727 (2).

The site at Hole-in-the-Wall Lake, Nahanni National Park, reported by Porsild (1961) was widely disjunct from the Alaska Panhandle sites shown on the map in Hultén (1968). The specimen reported here helps fill the gap between these widely separated areas.

Arnica cordifolia. 24387 (1).

This collection comes from an area intermediate between the sites shown on the map in Hultén (1968), and an apparently isolated site on the lower Liard River reported by Raup (1947).

Aster alpinus ssp. *vierhapperi*. 24783 (1).

This collection from the extreme southeastern part of the Yukon Territory will move the delimiting line in Hultén (1968) to the east, thus bringing it close to the populations in southwestern District of Mackenzie cited by Scotter and Cody (1974).

**Aster ciliolatus*. 24738 (2): 24775 (3).

These collections extend the known distribution of *A. ciliolatus* to the west from Fort Liard on the Liard River in southwestern District of Mackenzie (Jeffrey 1961).

Aster modestus. 24399 (1); 24356, 24648, 24784 (2).

Hultén (1968) indicated a collection from near Dawson and Porsild and Crum (1961) reported this aster at Liard Hot Springs in northern British Columbia.

**Bidens cernua* (Nodding Beggar-ticks). 24767, 24774 (3).

In central Alaska this species is known from the Yukon River drainage (Hultén 1968) while in the District of Mackenzie it is known from Nahanni National Park, Great Slave Lake, and the Slave River.

Erigeron philadelphicus (Pink Fleabane). 24336, 24340, 24350 (1); 24608, 24647, 24676 (2).

Hultén (1968) indicates a single Yukon Territory locality near Old Crow, from whence it has also been reported by Wein et al. (1974). Porsild and Crum (1961) reported it at Liard Hot Springs.

Hieracium scabriusculum. 24757, 24759B (3).

Hultén (1968) indicates two sites for this species, one near Watson Lake and another near Dawson.

Solidago canadensis var. *salebrosa* (Canadian Goldenrod). 24741 (2).

Hultén (1968) indicates collections from the vicinity of Dawson and Watson Lake.

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Notes

Fall Foods of Common Snipe on the Copper River Delta, Alaska

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Senner, Stanley E. and P. G. Mickelson. 1979. Fall foods of Common Snipe on the Copper River Delta, Alaska. Canadian Field-Naturalist 93(2): 171–172.

Stomachs from 22 Common Snipe (*Capella gallinago delicata*) collected at three sites on the Copper River Delta, Alaska, were examined to determine food habits. Cranefly larvae, *Prionocera* sp. (Tipulidae) were the most important food items and occurred in 75 to 86% of the stomachs. These and beetle larvae were the major foods, as previously shown for other breeding and staging areas in Canada.

Key Words: Common Snipe, food habits, Copper River Delta, Alaska.

Common Snipe (*Capella gallinago delicata*) breed primarily across boreal North America (Tuck 1972), although some are found breeding in arctic regions (e.g., Colville River, Alaska (Kessel and Cade 1958)). Most literature on snipe in Alaska concerns their distribution (e.g., Gabrielson and Lincoln 1959). There are no previous studies on food habits of snipe in Alaska, although Tuck (1972) described food habits of snipe at breeding and fall concentration sites in Canada. During fall the Copper River Delta in south-central Alaska may host several 10 000s of snipe (Isleib and Kessel 1973). The majority of these migrate south, presumably to wintering grounds from British Columbia to California (Burleigh 1955; Tuck 1972), although snipe rarely have been recorded in mid-winter on the western Copper River Delta (Isleib and Kessel 1973).

Study Area

Snipe were collected at three sites on the Copper River Delta. Nine snipe were from Mile 20 of the Copper River Highway (60°27′N, 145°16′W). *Carex* spp., *Eleocharis* spp., *Equisetum* spp., and *Hippuris vulgaris* dominated this meadow habitat. Five snipe were collected in mixed sedge-grass-forb habitat dominated by *Carex lyngbyaei, Deschampsia* sp., *Festuca rubra*, and *Hedysarum alpinum* along lower Alaganik Slough (60°26′N, 145°17′W). Eight snipe were from the east Copper River Delta (60°17′N, 144°56′W) in habitat dominated by *Alnus crispa*, *Myrica gale*, and *Carex lyngbyaei*.

Methods

All snipe were taken between 1 September and 10 October in 1976 (10 specimens) and 1977 (12 specimens). Contents of the snipe gizzard and proventriculus, and sometimes the esophagus, were removed and placed in Whirl-paks with hexamethylenetetramine-buffered formalin (Mueller 1972). Time between collection of the bird and removal of stomach contents varied up to several hours. Because of differential digestion rates and post-mortem digestion (e.g., Tuck 1972), only the number of stomachs with recognizable items are reported here.

Tuck (1972) suggested that frequency of occurrence (Hartley 1948) might be more meaningful than volume or weight for presenting food habits data. Our results are expressed in frequency of occurrence because volume or weight assigns great importance to large or difficult-to-digest items of food and underemphasizes the importance of small or easily digested food items. Vegetable debris, seeds, and mineral grit were not considered as food (Tuck 1972). White and Harris (1966) and Tuck (1972) found that plant fibers and seeds remained relatively unchanged by any digestive process and were finally regurgitated.

Results and Discussion

Nineteen of 22 snipe collected on the Copper River Delta contained food items (Table 1). The most important food items, represented by up to 43 individuals in a single stomach, were Cranefly larvae, *Prionocera* sp. (Tipulidae), which were present in 75 to 86% of the stomachs from all three sites (Table 1). The mean length of 26 intact larvae was 24.4 ± 5.82 mm.

Beetles, especially larval Dytiscidae (probably *Agabus* sp.) were the second most important item in the diet of snipe during fall (Table 1). These occurred in 14 to 75% of the stomachs from snipe collected from the three sites. Both cestodes and nematodes were found in snipe stomachs at Mile 20 (Copper River Highway) and Alaganik Slough, but neither was found in snipe taken on the east Copper River Delta. The nematodes did not appear to be parasitic on the snipe.

The results of this study agree with those summarized by Tuck (1972) in that insects, particularly

TABLE 1—Frequency of occurrence of food items in the stomachs of 19 Common Snipe collected at three sites on the Copper River Delta, Alaska

Food categories	Percent frequency of occurrence		
	Mile 20 (N=8)	Alaganik Slough (N=4)	East Copper River Delta (N=7)
Animal taxa			
Cestoda	12.5	50.0	—
Nematoda	25.0	25.0	—
Lumbricidae	12.5	—	—
Gastropoda, undetermined	12.5	—	—
Pelecypoda, undetermined	12.5	—	—
Insecta, undetermined	—	—	14.3
Diptera (total)	75.0	100.0	85.7
Tipulidae			
Prionocera sp. larvae	75.0	75.0	85.7
Pedicia sp. larvae	—	25.0	—
Chironomidae larvae	—	25.0	28.6
Coleoptera (total)	50.0	75.0	14.3
Undetermined adult	—	25.0	14.3
Dytiscidae larvae (largely *Agabus* sp.? and Hydroponidae)	37.5	75.0	14.3
Carabidae adult	12.5	—	—
Staphylinidae adult	—	—	14.3
Araneida, undetermined	—	25.0	—
Non-food items[1]			
Vegetable debris	87.5	75.0	100.0
Seeds	87.5	75.0	85.7
Mineral grit	100.0	75.0	71.4

[1]See Tuck (1972).

Diptera and Coleoptera larvae, are taken frequently. Tuck (1972) mentions that Tipulidae are especially significant, primarily on snipe breeding grounds, but also on fall staging areas in Canada. In northern latitudes Tipulidae are of great importance to other scolopacid shorebirds (see Chernov 1967; Holmes and Pitelka 1968). Our study has confirmed their value on an important staging and breeding ground for Common Snipe along the north Gulf of Alaska coast.

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Ivory Gull Colonies in Southeastern Ellesmere Island, Arctic Canada

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Frisch, T. and W. C. Morgan. 1979. Ivory Gull colonies in southeastern Ellesmere Island, Arctic Canada. Canadian Field-Naturalist 93(2): 173–174.

Five Ivory Gull colonies, ranging in population from about 12 to 60 birds, have been discovered in the upland icefields of southeastern Ellesmere Island. The colonies occur on cliff-faces of precipitous nunataks as much as 26 km from the nearest sea coast. One colony is established as a nesting site; the others are probable breeding places.

Key Words: Ivory Gull, Ellesmere Island, Arctic, colonies, nunatak nesting site.

Only one active breeding colony of the Ivory Gull (*Pagophila eburnea*) has heretofore been known from the North American Arctic: Seymour Island, a small low island north of Bathurst Island (MacDonald 1976). In the summer of 1977, while engaged in a helicopter-supported geological survey, the authors found five colonies of Ivory Gulls in the highlands of southeastern Ellesmere Island, an environment very different from that of Seymour Island. This note records the newly-discovered localities and our observations.

The area of Ellesmere Island that contains the colonies is bounded by latitude 78° 15′N and longitude 81° W and traversed by a major fiord, Makinson Inlet (Figure 1). Most of the land area comprises upland icefields and has a maximum relief of 1500 m; rock exposures are found mainly in coastal cliffs and nunataks. The terrain shown in Figure 2 lies north of Makinson Inlet between colonies 4 and 5 (Figure 1) and is representative of much of the area, which is underlain largely by metamorphic and granitic rocks of the Canadian Shield. The only permanent human settlement in the area is the small Inuit community of Grise Fiord, on the south coast of Ellesmere Island.

Positions of the five Ivory Gull colonies discovered are plotted on Figure 1 and more accurate locations in the Universal Transverse Mercator Grid system on National Topographic System 1:250 000 maps are given below. All sites are on rock ledges near the tops of steep cliff-faces of nunataks several hundred metres high at elevations of 450 to 750 m above sea-level. Only site 2, which was located purely by chance after the helicopter had landed and shut down, was observed at relatively close range. Owing to their inaccessibility, and lack of time and/or the threat of excessive disturbance by the helicopter, the other sites could not be examined closely. Numbers of gulls seen are very approximate and are based chiefly on estimates made during a single fly-past.

Information on each colony is listed in the following order: NTS 1:250 000 map sheet; approximate location on map; UTM easting and northing in Zone 17; approximate elevation above sea-level; distance to nearest sea coast; date of sighting; observer. Other details follow.

Site 1. Craig Harbour 49A; NE corner; 508600, 8532300; 750 m; 23 km; 11 August; TF. Sixty birds flying around cliff

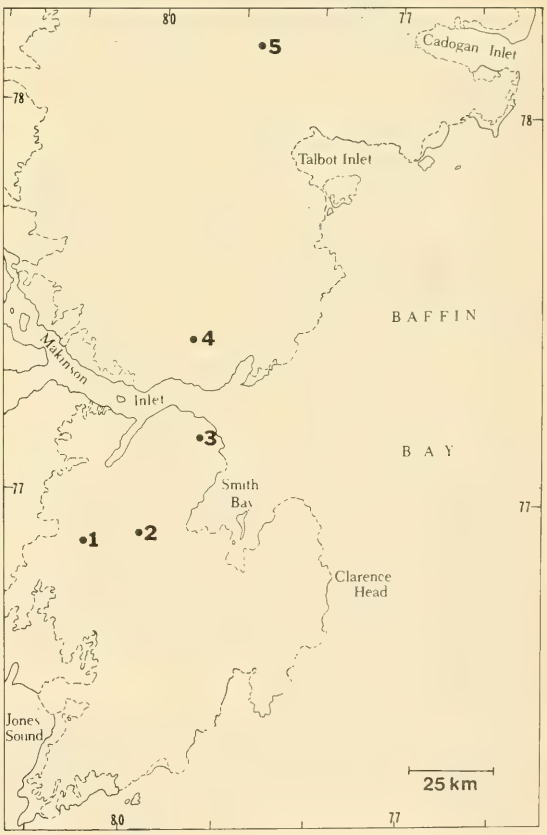

FIGURE 1. Sketch-map of southeastern Ellesmere Island showing five sites of Ivory Gull colonies. Broken lines mark the edges of icefields and glaciers but nunataks are not shown.

FIGURE 2. Typical terrain north of site 4.

and resting on ledges. A flat area on top of the nunatak was free of snow but not occupied by birds.

Site 2. Clarence Head 39B; NW corner, 526000, 8537400; 450 m; 14 km; 12 August; WCM. Twelve to 15 birds seen near top of cliff. Four large young birds visible by eye in nests on excrement-stained ledges. No unhatched eggs were visible through binoculars. Observations were made from an icefield looking down on the site across a gully.

Site 3. Talbot Inlet 39C and part of 39D; Thorndike Peaks; 541200, 8565000; 600 m; 6 km; 12 August; WCM. Fifty birds in the air, resting on ledges, and taking off from ledges.

Site 4. Talbot Inlet 39C and part of 39D; Inglefield Mountains; 543600, 8597600; 600 m; 12 km; 29 June; WCM. At least 50 birds suddenly encountered when helicopter flew around corner of nunatak.

Site 5. Ekblaw Glacier 39F and 39E; head of Cadogan Glacier; 549900, 8679000; between 600 and 750 m; 26 km; 15 August; TF. Thirty birds on ledges and flying around nunatak.

Site 2, southwest of Smith Bay (Figure 1), is thus established as a new breeding place of the Ivory Gull. Although we have no direct evidence of breeding at the other localities, we consider it more than probable that these are also nesting sites.

Nesting sites of the Ivory Gull similarly situated on nunataks well inland from the coast have been reported from southern Vestspitsbergen by Birkenmajer and Skreslet (1963) (see also Løvenskiold 1964). No doubt sites of this type are used because, among other factors, they provide a haven safe from predators. Furthermore, Polar Bear (*Ursus maritimus*) kills provide a major source of food for the Ivory Gull (MacDonald 1967, p. 6) and all the Ellesmere Island sites are relatively near the east coast, which, according to our observations, supports a sizable bear population, particularly in Smith Bay.

Our chiefly aerial coverage of southeastern Ellesmere Island was by no means complete and, judged from essentially chance discoveries of five colonies and a number of sightings of individual Ivory Gulls, it seems certain that more colonies exist in the upland icefields. Also, our sightings lend credence to unconfirmed reports from the 19th century of a breeding place on the east coast of Ellesmere Island, north of the area described here (MacDonald and Macpherson 1962). In any event, southeastern Ellesmere Island is now established as an important breeding ground of the Ivory Gull.

Acknowledgments

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Wind-caused Death of Great Cormorant

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McNicholl, Martin K. and Geoffrey G. Hogan. 1979. Wind-caused death of Great Cormorant. Canadian Field-Naturalist 93(2): 175.

Key Words: Accidental death, Great Cormorant, Prince Edward Island, weather, wind.

At 18:32 on 10 April 1977, McNicholl watched an adult Great Cormorant (*Phalacrocorax carbo*) fly from the open sea to ledges near the top of a cormorant colony cliff at Cape Tryon on the northern shore of Prince Edward Island. Strong north winds, rated as 5 or more on the Beaufort scale (= 29–38+ km/h), were blowing at the time, and visibility was reduced by blowing snow, although the snow also heightened light levels. The bird tried three times to land, but each time gusts caused it to circle back towards the sea. On the fourth approach, the bird was gliding into a position from which it could land when a sudden gust of wind threw it breast-first into the cliff face. The bird flapped one wing twice, then ceased all motion. A Common Raven (*Corvus corax*) attempted to land near the corpse 2 min later, but was unable to do so. The next day a raven was eating the dead bird. On 4 April, another day of strong north winds with sudden gusts, McNicholl observed another adult Great Cormorant to be blown about 30 m along the cliff-face on attempting to land. This bird was able to land briefly at the new locale along the cliff, but was driven away by other birds there. These observations were made during regular checks of the colony from a cleft in the cliff which hid the observer from birds not actually perched on ledges on the cliff. This cleft was over 200 m from the spot where the bird was killed. McNicholl visited the colony from 22 March to 22 April during which period cormorant activity declined markedly on days with gusty winds, but birds were able to land readily in high winds if these were steady.

Byrd and Tobish (1978) attributed the deaths of 48 chick and two adult kittiwakes (*Rissa brevirostris* and *R. tridactyla*) to wind during a violent storm in Alaska, but did not observe the precise manner of deaths. There are many reports in the literature of deaths of birds during storms, and several reports of deaths by collison with man-made objects (see review by Weir 1976), but we are not aware of other reports of deaths caused by collisions at familiar colony sites in winds not associated with violent storms. The above observations suggest that strong gusty winds could pose a serious problem to large seabirds at cliff colonies. Stonehouse (1964) mentioned that frigatebirds (Fregatidae) have difficulty in landing during strong winds, but did not attribute deaths to this cause.

These observations were made during a study by Hogan under the supervision of R. D. Morris. Financial support was provided by the Prince Edward Island Fish and Wildlife Division of the Department of the Environment, a National Research Council of Canada grant to R. D. Morris, and an Ontario Graduate Scholarship to Hogan. The manuscript was improved on the basis of comments by R. K. Ross and an anonymous reviewer.

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Habitat Selection by Wintering Snowy Owls (*Nyctea scandiaca*)

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Lein, M. Ross and G. A. Webber. 1979. Habitat selection by wintering Snowy Owls (*Nyctea scandiaca*). Canadian Field-Naturalist 93: 176–178.

Habitat selection by Snowy Owls (*Nyctea scandiaca*) wintering near Calgary, Alberta, was studied in 1973–1976. Habitats were classified as being residential, fallow, stubble, hayfield, or pasture, and areas of each were determined. Compared to the relative areas of the various habitats, owls were seen more frequently in stubble and hayfields, and less frequently in the other three habitat categories. This selection is believed to be related to the varying densities and accessibility of small mammals in the different habitats.

Key Words: Snowy Owls, habitat selection, winter, prairie farmland, prey availability.

Studies of the behavioral ecology of the Snowy Owl (*Nyctea scandiaca*) in winter are sporadic and incomplete. Gross (1927, 1931, 1944, 1947) documented several irruptions between 1926 and 1946 but did not obtain comprehensive information on aspects of the owls' ecology other than food habits. Most subsequent publications deal with unusual locality records or numbers of birds, or with food habits, although a few (Keith 1960, 1964; Quilliam 1965; Weir 1973) consider other behavioral or ecological aspects. The virtual lack of intensive or long-term investigations of the biology of the species in areas where it regularly winters is especially surprising since some owls may actually spend more time in the south than on their arctic breeding grounds (Bird 1972).

The senior author began a long-term study of wintering Snowy Owls near Calgary, Alberta in 1973. Snowy Owls have been recorded in numbers in this area every winter since 1964–65 (Bird 1972; personal observations). This note reports some initial findings of this investigation on the habitats utilized by owls on their winter range.

Methods

Each winter from 1973–74 to 1975–76, 8–12 survey routes were censused by members of the Calgary Field Naturalists' Society, using a modification of Gollop's (1965) procedure. Each 64-km (40-mi) route was surveyed every 2–4 wk by two volunteers who drove the route at a speed of 30–50 km/h, stopping every 3.2 km (2.0 mi) to scan the surrounding area with binoculars. Each owl's location was plotted on a topographic map and pertinent standardized data, including a habitat description, were recorded.

This analysis is limited to one route in 1974–75 and three routes in 1975–76 because of the effort involved in calculating the habitat composition of routes and the availability of recent aerial photography. The routes chosen were the most productive in terms of total owls recorded, and were located in mixed agricultural land, just east of Calgary.

A habitat map was prepared for each route, including an area extending 1.6 km (1.0 mi) on each side of the survey route and 1.6 km before the beginning and after the ending of the route. The nature of each field or other habitat unit was identified from aerial photos or by direct inspection. All habitat determinations were made after cultivation ceased in the fall and prior to its resumption in the spring. Areas of each habitat on each route were estimated using the standard dot grid method.

We recognize five habitat types on the study area:

1. Residential: farmyards, rural residences, feedlots, hamlets, and other areas of high human activity.
2. Summerfallow: cultivated fields where either no crop was planted during the previous growing season or the stubble was ploughed up after harvest. These areas are virtually bare earth with only traces of plant material on the surface.
3. Stubblefields: areas where cereal crops have been grown and harvested, leaving only the basal 10–20 cm of the stems. Fields usually persist in this form until ploughing and seeding in the following spring.
4. Hayfields: areas planted to non-native grasses and cut yearly for livestock fodder. They are rarely used as pasture and are ploughed and reseeded at intervals of longer than one year.
5. Pastures and Sloughs: areas not subjected to annual cultivation for the raising of cereal crops or hay, often marginal land which may be used as pasture for livestock. Sloughs fill with spring runoff but are typically dry throughout much of the summer, autumn, and winter. This is a highly heterogeneous category which is not easily subdivided.

We tallied the survey results by the habitat in which each owl was located when sighted. When an owl was perched on a fenceline that represented a boundary

between two different habitats, a value of 0.5 owl was assigned to each of the two categories.

Results

The distribution of habitat classes on the survey routes is presented in Table 1. The major category is stubblefields, comprising almost 60% of the area. Residential areas are a very minor category.

The distribution of owl sightings across these habitat classes is also shown in Table 1, along with an expected distribution of sightings based on a null hypothesis of no habitat selection. The observed distribution is significantly different from that expected (chi-square goodness of fit test, $P < 0.01$), demonstrating a degree of habitat selection. Owls are recorded more frequently than expected in stubble and hayfields, and less frequently than expected in the other three habitat categories.

Discussion

The overall preference for open habitats by wintering Snowy Owls is well-known (Bent 1938; Gross 1947; Keith 1960). In the Calgary area, most owls are found in agricultural land east of the city; few birds are observed in the more wooded aspen parklands or foothills to the west (Bird 1972; M. R. Lein, unpublished data). A similar avoidance of wooded regions is noted elsewhere (Gross 1947; Nagell and Frycklund 1965); however, the present study appears to be the first attempt to demonstrate habitat selection by Snowy Owls at a finer level.

We suggest that the preference for stubblefields and hayfields is related to the availability of small-mammal prey in such areas, as would be predicted by optimal foraging theory (MacArthur and Pianka 1966; Pyke et al. 1977). Summerfallow fields are relatively barren and offer little to rodents either in cover or food. Pastures are usually heavily grazed and offer little cover for small mammals. Non-grazed sloughs and roadside ditches offer excellent cover for rodents, which are relatively abundant in such habitats (P. C. Boxall, unpublished data), but rank vegetation and deep snow cover may sharply limit their availability to owls. Low numbers of owls around residential areas may be a direct response to human disturbance. Thus, the habitat distribution of the owls suggests that they may be choosing areas (stubblefields and hayfields) in which rodents are both relatively numerous (P. C. Boxall, unpublished data) and available to predators.

It is perhaps surprising that a more pronounced degree of habitat selection is not shown. Several reasons may be suggested. The first is the relatively crude level of the analysis. Owls certainly do not categorize habitats in the same manner as do human investigators, and an analysis of distribution using different habitat classes might show more striking differences. Second, and perhaps more important, is the implicit assumption of the present study that the owls recorded in a habitat were actually choosing it as a hunting area. Although hunting attempts have been observed in all habitats throughout the day, it is possible that owls may choose different areas for roosting and "loafing" than those in which they hunt. We know very little about the hunting behavior or activity cycles of wintering Snowy Owls. Owls tend to use elevated perches such as trees or utility poles early in the morning and toward sunset (Keith 1964; M. R. Lein, unpublished data) and to perch on or near the ground during mid-day. It has been suggested that these high perches are hunting perches and that this represents a diurnal pattern of hunting behavior. Unfortunately, most of the data used in this study were gathered during the middle of the day and are unsuitable for a test of such an hypothesis. If it were possible to identify owls likely to be actively hunting, and to carry out the analysis on only those owls, stronger habitat selection might be expected.

Acknowledgments

We thank those members of the Calgary Field Naturalists' Society who conducted owl surveys; this study would not have been possible without their efforts. We gratefully acknowledge P. C. Boxall for providing us with preliminary results of his investigation on Snowy Owls, and for commenting on the

TABLE 1—Distribution of habitats, and of owl sightings, on the survey routes analyzed.

	Habitat category					
	Residential	Fallow	Stubble	Hayfield	Pasture + slough	Total
Percentage of total area	1.81	15.12	58.48	6.55	18.04	100.00
Number of owls observed	2.5	20.5	116.0	18.0	18.0	175.0
Number of owls expected	3.17	26.46	102.34	11.46	31.57	175.00

manuscript. T. E. Dickinson also provided helpful suggestions. Financial support was received in the form of operating grants from the University of Calgary and the National Research Council of Canada to M. R. Lein.

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Two-lined Salamander, *Eurycea bislineata*, in Labrador

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Cook, Francis R. and John Preston. 1979. Two-lined Salamander, *Eurycea bislineata*, in Labrador. Canadian Field-Naturalist 93(2): 178–179.

In mid-August 1972 a single Two-lined Salamander, *Eurycea bislineata*, was collected by J. P. approximately 16 km (10 mi) NE of Labrador City on the west side of a small brook that drains into Moose Head Lake, about 0.6 km (1 mi) upstream from the lake (52° 58′N, 66° 40′W). The specimen is a recently transformed juvenile 63 mm in total length and 29.5 mm snout to anterior margin of vent. It is catalogued as National Museum of Natural Sciences (Herpetology Section) 17948.

This is the first example of the species collected in Labrador and is a 290-km (180-mi) range extension north of the nearest records on the north shore of the Gulf of St. Lawrence (Bleakney 1958, map 85; Logier and Toner 1961, map 19; Power 1965). Based on two collections which have not been previously documented, Conant (1975, map 240) shows that in interior central Quebec the range of the Two-lined Salamander extends north to near the latitude of southern Labrador. These collections are a single specimen from the Lac Charon area 32 km (20 mi) from Chibougamau taken by Jean-Guy Rossignol 3 July 1967 (NMNS 10287), and five specimens collected along the Rupert River, 48 km (30 mi) west of its source at Lake Mistassini approximately 20 July 1967 by Daniel Roy (American Museum of Natural History 88025-29; transmitted by Roger Conant).

Bleakney (1968, map 82) plotted a record of the Red-backed Salamander, *Plethodon cinereus*, in the Lake Melville area of central Labrador. This was based on a report from W. J. Smith who in the summer of 1955 had the local occurrence of a small salamander mentioned to him on several occasions (Bleakney 1958, p. 15). Because of gross similarities between *Plethodon* and *Eurycea*, however, we suggest that this record may be more logically assigned to the latter and

suggest a wider Labrador range for it than our single specimen establishes. The presence of *Eurycea* in Labrador and central Quebec is a further indication of the need for a northward revision of Bleakney's Herpetofaunal Section 5 to include his previously disjunct Section 5A as has already been proposed by Cook and Folinsbee (1975) on the basis of recent records for the Blue-spotted Salamander, *Ambystoma laterale*, the only other salamander verified for Labrador to date.

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First Canadian Record of a Flathead Catfish

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Crossman, E. J. and J. H. Leach. 1979. First Canadian record of a Flathead Catfish. Canadian Field-Naturalist 93(2): 179–180.

Pylodictis olivaris was captured in the Canadian waters of Lake Erie on 22 August 1978. This is a 30-km range extension north and is the first Canadian record.

Key Words: Flathead Catfish, *Pylodictis olivaris*, Canadian record, Lake Erie.

A live specimen of *Pylodictis olivaris*, the Flathead Catfish (Ictaluridae), was netted in Lake Erie and constitutes the first time the species has been captured in Canadian waters.

The fish was taken by Rudy Krause, of K. W. Krause and Sons Fisheries, Leamington, Ontario, on 22 August 1978. It was caught in a commercial trapnet west of Point Pelee, 4.8 km north of the tip of the point (41°56′50″N, 82″31′40″W). The bottom of the net site was silty clay and the water temperature at the time of capture was 24.3°C.

The catfish was 52 cm in total length and weighed 1.79 kg. Trautman (1957) indicated that the species has been known to reach 134.6 cm length and 37.2 kg weight. The Canadian specimen had a noticeable deformity of the middle region of the caudal vertebrae, but otherwise agreed with the morphological characteristics of the species as given by Trautman (1957) and Hubbs and Lagler (1964). The most striking feature other than head shape, which separates this species from other local catfishes, is the strong backward extensions of the premaxillary tooth-patches. These were very obvious in this specimen.

The species has long been known in the United States waters of Lake Erie, and Trautman (1957) indicated records north to the international boundary. This latest record from the northern side of Lake Erie itself represents a range extension of 30 km north of previous records and is somewhat unusual because this species is more abundant in the Ohio River and its tributaries than in the Lake Erie portion of Ohio. Trautman listed only five specimens taken in the Lake Erie waters of Ohio from 1938 to the date of writing (1956?). He suggested that "there appears to be a small population . . . in the Huron River, where they are taken yearly." The mouth of the Huron River in Ohio is due south of Point Pelee.

In describing the total range of the species, Hubbs and Lagler (1964) called it rare in Lake Erie and mentioned that it is usually a large-river form. This catfish had not been previously reported from

adjacent Canadian waters, in spite of the intensive commercial fishery in that area. It was the only specimen seen so that it is impossible to say now whether it is a stray or whether a small population has already been established in the Point Pelee area.

The shallow waters from western Lake Erie to Lake St. Clair have contributed most of the limited number of records of freshwater fishes that have moved north into Canadian waters over the past 25 yr. Catches in those waters should be carefully scrutinized and all unusual items reported.

The specimen has been added to the reference collection of the Royal Ontario Museum (ROM Cat. No. 34561).

We thank Rudy Krause for his care in recognizing that the fish was different, and for taking the trouble to turn it over to the Ontario Ministry of Natural Resources.

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Earthworm Cocoons as a Drift Component in a Southern Ontario Stream

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Schwert, D. P. and K. W. Dance. 1979. Earthworm cocoons as a drift component in a southern Ontario stream. Canadian Field-Naturalist 93(2): 180–183.

Cocoons representing at least six species of Lumbricidae were isolated from drift subsamples of a stream in Waterloo County, Ontario in the wpring of 1976. Of the 308 cocoons, 92% were viable. We present arguments to support cocoon drift as a potentially important mechanism in lumbricid dispersal.

Key Words: cocoons, Lumbricidae, Oligochaeta, biological drift, dispersion, Ontario, geographical distribution.

In southern Ontario, as in many other regions of North America, large populations of lumbricid earthworms often occur in moist lowlands adjacent to streams and lakes. When temperature, moisture, and light conditions permit, a number of the lumbricid species in these areas are active on or just below the soil surface. Significant activity combined with surface runoff from rainstorms and snowmelt can result in large numbers of earthworms and their cocoons becoming trapped in waterways. Their subsequent downstream drift might be expected to be a significant factor in lumbricid dispersal, but this mechanism has remained poorly studied. Bouché (1972) hypothesized that stream drift had an important influence on the distribution of some hygrophilic lumbricid species in France, and Ward (1976) applied a similar hypothesis to explain the recolonization of a riffle area by the lumbricid *Eiseniella tetraedra* in a Colorado stream. No published observations of the drift of lumbricid cocoons exist, however, probably because these might be easily confused with plant seeds during sorting.

During the latter 5 mo of a 13-mo stream drift study in southern Ontario (Dance and Hynes, *in press*), sorting of earthworm cocoons from freshly collected drift samples was initiated. We present here data on this component and suggest its possible significance with respect to lumbricid dispersal.

The Study Area

All of the examined cocoons were obtained from drift samples of two headwater branches of Canagagigue Creek in a predominantly agricultural region immediately north of Floradale in Waterloo County, Ontario (43°39′N, 80°35′W). Stations 1 and 2 were located on the permanent, spring-fed east branch of

the creek. Stations 3 and 4 were located on the west branch, an intermittent stream which flowed continuously during the five months of this study. Station 1 was a gravelly riffle, in a treeless pasture 350 m downstream from a White Cedar (*Thuja occidentalis*) woods. Station 2 was a cobble and boulder riffle at the downstream margin of an extensive American Beech (*Fagus grandifolia*) and Sugar Maple (*Acer saccharum*) stand. Station 3 was at the downstream edge of a short, silty riffle in a treeless pasture. The streambank at Station 4 was lined with herbs and *Salix* spp., and the bed consisted of boulders and cobbles resting on silts.

Methods

Drift was subsampled continuously using a specially designed apparatus of 253 μm Nitrex cloth net mounted over an aluminum and steel frame (Dance et al., *in press*). Water flowed without wave interference through a vertical opening 1 cm wide and 100 cm high into a long sample bag. The contents of the trap were placed weekly into a plastic bag and frozen until sorting. Under a binocular microscope, cocoons were sorted from thawed samples which had been collected between February and June 1976 and placed into labelled vials of 70% ethanol.

Attempts at placing generic or specific names on the cocoons were inhibited by distortions in the cocoon shape resulting from the sample procedures and by the frequent absence of the diagnostic end "tufts" which had apparently broken off during the turbulence of drift. Names could, therefore, be placed on only a small number of the cocoons through comparison with a cocoon reference collection and with the cocoon descriptions in Evans and Guild (1947) and Gerard (1964).

Mean monthly discharge volumes during the study period for each of the sample stations were calculated from data on the creek provided by the Canada Water Survey and the School of Engineering at the University of Guelph. Utilizing this information and the calculated average component of the total discharge continuously subsampled by each trap (for detailed procedure, see Dance et al., *in press*), a multiplication factor was derived estimating the total monthly number of cocoons passing each sample point.

Results

A summary of the mean monthly discharge values for the four Canagagigue Creek sample stations is presented in Table 1. Discharge volumes fluctuated widely for each station during the study period but for all four were maximal in March and minimal in June.

Monthly summaries of the actual cocoon content of the drift samples and of the estimated total cocoons flowing past each station are presented in Table 2. Cocoons were absent from all February samples, but maximum numbers were recorded in March at the east branch stations and in April at the west branch stations; the west branch stations were inoperable during most of March because of flooding. Except for a sharp increase in June numbers at Station 2, the incidence of cocoons generally decreased into the early summer.

TABLE 1—Estimated mean 1976 monthly discharge (L/s) for four Canagagigue Creek drift sample sites (Waterloo County, Ontario)

	Station			
Month	1	2	3	4
Feb.	202	455	3174	3398
Mar.	901	1126	3066	6089
Apr.	271	410	394	446
May	151	275	220	298
June	148	241	47	87

TABLE 2—Summary of the 1976 monthly totals of earthworm cocoons per drift trap (and estimated total cocoons flowing past each sample station) for four Canagagigue Creek drift sample sites in Waterloo County, Ontario, and their percent viability

	Number of cocoons (estimated total) Station					
Month	1	2	3	4	Cocoon total	Numbers of viable cocoons (% of monthly total)
Feb.	0 (0)	0 (0)	0 (0)	0 (0)	0	— (—)
Mar.	52 (17 731)	42 (22 105)	Flood	Flood	94	88 (93.6)
Apr.	34 (5964)	33 (9167)	10 (1149)	52 (11 556)	129	110 (85.3)
May	22 (4000)	6 (1875)	1 (88)	8 (2963)	37	36 (97.3)
June	18 (3529)	29 (13 809)	0 (0)	1 (345)	48	48 (100.0)
Total					308	282 (91.8)

Nearly 92% of the cocoons were found to contain sperm and albumen, or some stage in the development of the embryonic mass, and these were termed "viable," or potentially capable of hatching.

All cocoons resembled in general form those of the Lumbricidae. A qualitative examination of the undistorted component yielded cocoons resembling the following taxa in the family: *Aporrectodea* spp., *Dendrodrilus rubidus, Eisenia fetida, Eiseniella tetraedra, Lumbricus terrestris, Octolasion teyrtaeum.*

We have collected adults of each of the above species from sites in Waterloo County, and all of the species have been recorded from southern Ontario by Reynolds (1977). One adult *Eisenia fetida* and one adult *Eiseniella tetraedra* were also collected from the drift samples.

Discussion

Fluctuations in the monthly totals of the observed cocoons undoubtedly reflect both the physical state of the environment and the cocoon production of the local fauna. The absence of cocoons from the February samples would be expected because of the frozen condition of the soil, but the March and April cocoon peaks are probably the result of both the high rate of surface runoff from snowmelt and rain and a high degree of surface activity and cocoon production by the earthworm fauna. The precise distances which any of the cocoons drifted to the trap sites remains unknown, although presumably none of the cocoons were derived from sources greater than 2–3 km upstream, the area of the upper Canagagigue watershed.

The small size (< 6 mm) and tough, spheroidal outer walls of lumbricid cocoons are ideally suited for long and rigorous transport in streams. Individuals of several lumbricid species have been shown to be capable of prolonged submersion (Roots 1956; Edwards and Lofty 1972), and the successful hatching and growth while submerged of the lumbricid *Allolobophora chlorotica* has been demonstrated by Roots (1956). From these studies and from the remarkably high viability of the drift cocoons of the present study, successful hatching of cocoons could be expected in areas of a stream where the cocoons had been deposited near the margin or in the bottom sediments of pools. A major consequence, therefore, would be the establishment of the transported species in lowland areas along the stream.

Because cocoons have subsequently been obtained from random drift samples in other streams of southern Ontario and of Newfoundland, the phenomenon of cocoon drift appears to be widespread. We have also collected large immature and adult Lumbricidae from other streams in Ontario, as well as in Newfoundland, New York, and Pennsylvania. Although these worms survived submergence in rigorous environments, the battered nature of many of the specimens indicates that these large, soft-bodied stages have difficulty in physically surviving prolonged transport. In addition, this stage is particularly susceptible to predation by fish; the palatability of cocoons to fish is unknown, but presumably low.

The successful drift of cocoons may be of considerable importance in explaining the modern distribution of many lumbricid species in North America. All of the species identified from Canagagigue Creek are of taxa hypothesized by Gates (1970) and Reynolds (1974) as having been introduced into North America from Europe. The widespread distribution of many of these species across Canada and the United States is attributed by Gates (1976) as being primarily due to transport by human activity. While man has undoubtedly influenced earthworm distribution, he cannot, as Ball (1975) argues, logically claim responsibility for the entire distribution of lumbricid earthworms across the continent. Transport of cocoons, however, from one point of intensive lumbricid establishment upstream to other points downstream could result in the subsequent colonization of the lower watershed by these species. Although further investigation is needed to support this mechanism, stream drift may be as important to the dispersal of earthworms as it is to many other groups of invertebrates.

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Flowering Plant Phenology at Sheep Mountain, Southwest Yukon Territory

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Hoefs, M. 1979. Flowering plant phenology at Sheep Mountain, southwest Yukon Territory. Canadian Field-Naturalist 93(2): 183–187.

The dates of initiation of flowering of 60 vascular plant species in the Kluane Lake area, Yukon Territory, are presented for the 1970, 1971, and 1972 seasons. The altitudinal advance of plant development is determined, using *Carex filifolia* as the indicator species.

Key Words: phenology, flowering plants, subarctic botany, *Carex filifolia*, Kluane Lake, Yukon Territory.

The data presented here are part of a larger investigation carried out on Dall Sheep (*Ovis dalli dalli*) and their range in the Kluane Lake area of the Yukon Territory since 1969. The specific study area is "Sheep Mountain," an important winter range of a Dall Sheep population located at the southeast shore of Kluane Lake near the mouth of the Slims River (61°00′N, 138°30′E). For details on the vegetation, climate, geology and soil of the area, the reader is referred to Hoefs et al. (1975) and for details on the sheep population, their range use patterns, and forage selection, to Hoefs (1975).

During this investigation it became clear that a number of activities of sheep, for instance forage selection, use of various plant communities, and vertical migration, were closely linked to plant phenological phenomena. A number of these were investigated.

My studies (Hoefs 1974) have demonstrated that the flowers of certain plant species are preferred forage items for Dall Sheep. This paper deals with the dates of initiation of flowering of 60 vascular plants on Sheep Mountain.

A number of factors have been used to explain the vertical seasonal movements of ungulates; these include snow conditions and other weather factors, avoidance of blood-sucking insects, protection of winter ranges, and advantages with respect to forage (Dixon 1938; Murie 1944; Blood 1963; Egorov 1967; Hebert 1972). Some indications of the vertical march of phenology can be obtained from the dates of first flowering of plant species at different altitudes. A more accurate quantification, however, is possible by observation of the performance of the same species of plant at various altitudes. This study determined altitudinal advance using *Carex filifolia* as the indicator species. *Carex filifolia* was selected because it is (*a*) a fairly abundant plant in all dry grassland associations in the boreal, subalpine, and alpine biogeoclimatic zones of the study area (Hoefs et al. 1975); (*b*) one of the most preferred Dall Sheep forage plants (Hoefs 1975); (*c*) an "early bird" in a phenological sense, flowering earlier and reaching the annual maximum of growth before any of the other important forage plants (Figure 1).

Methods

Sixty species of flowering plants, known to be used by sheep (Hoefs 1975), were mapped and marked by wooden stakes on Sheep Mountain in 1969. The dates

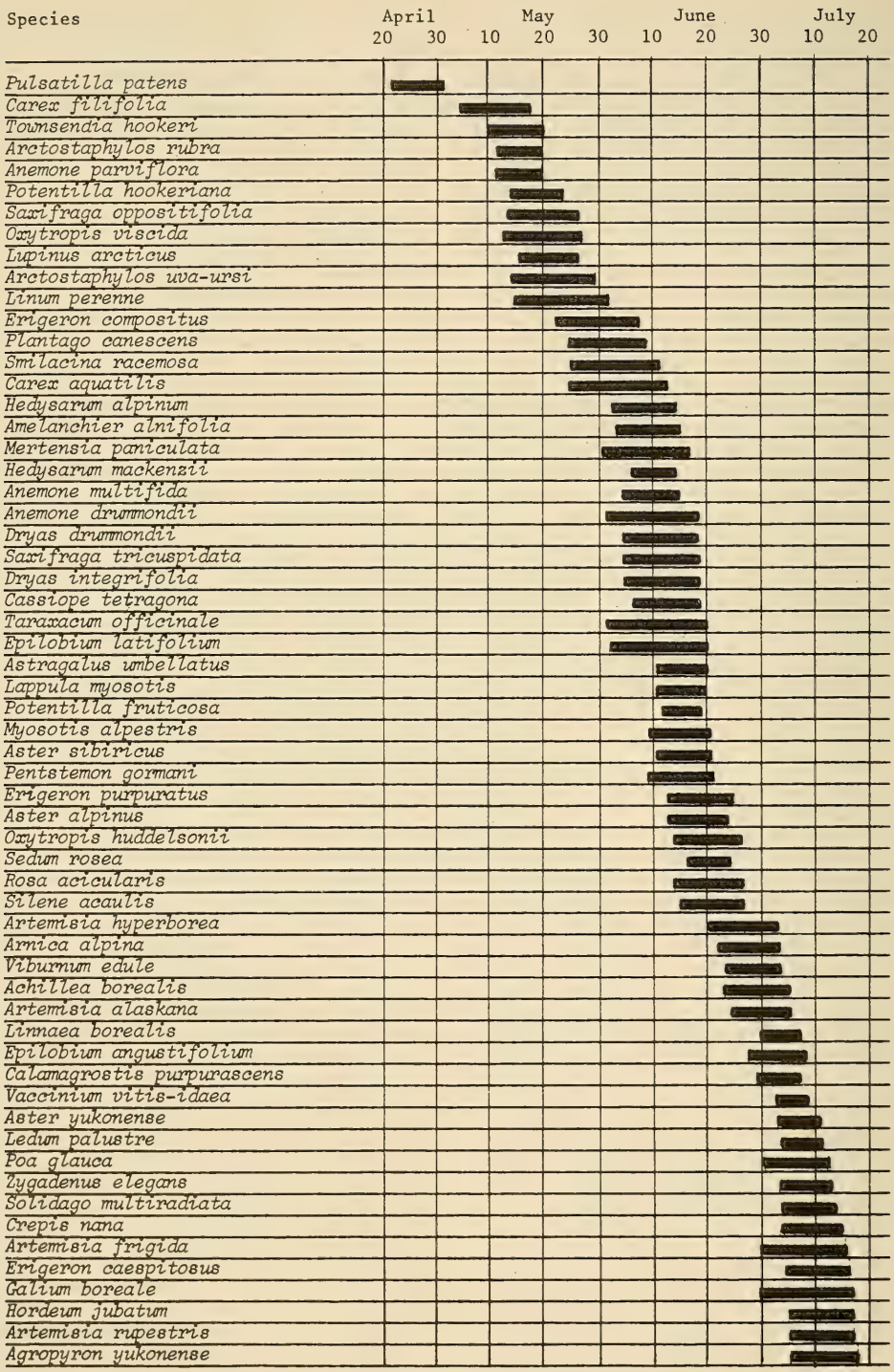

FIGURE 1. Dates of first flowering of Sheep Mountain plants for 1970, 1971, and 1972.

at which these plants first developed fully opened flowers were recorded during 1970, 1971, and 1972 seasons.

Ten clumps of *Carex filifolia* were selected at each of five altitudinal sites (935, 1000, 1330, 1590, and 1910 m) and measurements of growth, flowering, fruiting, and initiation of dormancy were carried out at weekly intervals from early May to late October 1970. The selected clumps were protected from grazing by exclosure fences.

Nomenclature of plant species follows Hultén (1968) with the exception of *Artemisia hyperborea*, which is described in Porsild (1966).

Results and Discussion

Dates of First Flowering

Figure 1 lists 60 flowering plants that grow on the range of the Dall Sheep population under study, and gives their first flowering dates arranged approximately in chronological sequence. Because observations were carried out over three seasons, with considerable differences in weather patterns, the first flowering dates are ranges of 10 d to 2 wk and not individual days. Great variations were observed particularly between the spring of 1971 compared to 1970. Some flowers came into bloom as much as 12 d earlier in 1971. The data of Figure 1 can therefore be interpreted as follows: beginning of range is initial flowering date in 1971, end of range is initial flowering date for 1970. The date for 1972 is about half-way between those two extremes. The data presented here, particularly for June when many plants came into bloom, must be considered as approximations since it was not physically possible to check every marked species every day. It is unlikely, however, that any of the dates are in error by more than 4 d.

Figure 1 includes a number of species which grow in various altitudes and in various plant associations (aspects) at the same altitude. Even though only specimens growing in the most "advanced" sites in a phenological sense, which were usually south-facing slopes in the boreal zone, were marked and are considered in Figure 1, records were kept on the delays observed if such species also grew on north-facing slopes and at higher elevations. Detailed information on the floristic composition of the various plant associations on Sheep Mountain, and their distribution with respect to aspect and altitude are given in Hoefs et al. (1975) and need not be repeated here. In general it was found that there was a 10- to 14-d delay in plant development between north- and south-facing slopes at the same altitude, and a delay of about 1 d for each 35 m of altitude at the same aspect. An example may demonstrate this point. *Pulsatilla patens* is the first plant, with the exception of willows, to have open flowers. On sunny, south-facing protected slopes with grassland vegetation in the boreal zone (1000 m), its flowers may in favorable springs (1971) be seen as early as 22 April. This species grows also in alpine elevation (1667 m), where it did not come into bloom before 17 May (1971). Figure 1 reveals that *Pulsatilla patens* is the only species that may come into bloom in April, about 26 species begin to bloom during May in an average year, 19 species in June, and 15 species in July. Although there are many exceptions to this rule it is in general true that members of the families Ranunculaceae and Leguminosae are among the first to come into bloom while members of the Compositae and Gramineae families are among the last.

Altitudinal Advance of Plant Development

Figure 2 shows the growth curves of *Carex filifolia* at five sites with increasing altitudes. Lines connecting the points at which 50% and 100% of the annual growth was achieved give an indication of the vertical phenological march. For reasons as yet unexplained, the plants at an elevation of 1000 m were phenologically more advanced than those at an altitude of 935 m. One reason may have been that the plants at the lower altitude were more often subject to shade cast by surrounding trees during the course of a day. Because the lines connecting 50% and 100% growth points are parallel it will suffice to discuss one of them. At an altitude of 1000 m *Carex filifolia* reached its maximum annual growth around 18 June, at 1330 m around 26 June, at 1590 m around 5 July, and near the peak of Sheep Mountain, at 1910 m, it took till 15 July, 1970.

The speed of vertical advance of plant development was therefore 910 m per month or about 315 m per 10 d. It is not possible to quantify within similar terms the sequence of dry-up, since this is influenced not only by temperature or altitude but also by moisture deficiency. This speed of vertical advance agrees with Hopkins' (1920) bioclimatic law, which states that there is a delay in vegetation development of about 3 to 4 d for each 100- to 130-m increase in altitude, as well as with Stoddart and Smith's (1955) remark that "Most observers agree that the (altitudinal) difference approaches one day for each 100 feet of altitude."

My studies documented a very close relationship between vertical migrations of Dall Sheep and plant phenology, particularly in spring. During May and June sheep leave their winter ranges and move up high, making use of plant associations with new growth and avoiding others that are still dormant. This pattern of range use continues on summer range, where advanced plant associations on south- and west-facing slopes were primarily used in June and early July while plant associations on east and northern aspects were used in late July and August. Selection with respect to phenological stage was also

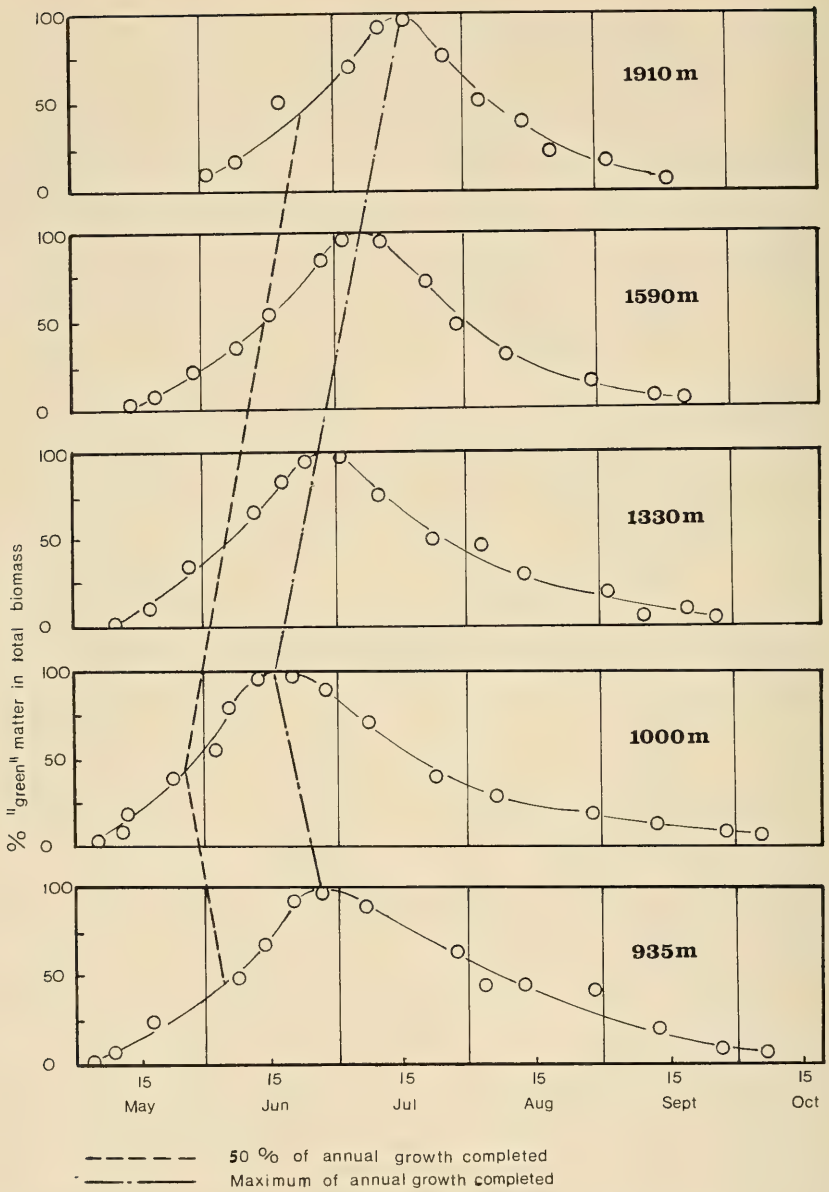

FIGURE 2. Growth of *Carex filifolia* at various altitudes in 1970, demonstrating vertical phenological advance.

observed when feeding took place within one plant association. New growth was preferred to the mature and dormant stage of a species. Special attention was paid to flowers, particularly large and showy ones. *Pulsatilla patens* and *Oxytropis viscida* flowers are important forage items in early spring when the sheep are still on winter range, while *Pedicularis* spp., *Dryas integrifolia, Hedysarum alpinum, Epilobium latifolium,* and *Oxytropis huddelsonii* flowers are important on alpine summer range. Fall migration from alpine summer ranges commences in late August and early September. Only ewes and lambs, however, appear to arrive at lower elevations in time to utilize certain plant species that are still "green." Heavy use is made at this time of the various willow species in the subalpine shrub zone (1200 to 1600 m), when all the

vegetation of the alpine zone is already dormant. Forage selection and range use patterns are dealt with in detail in Hoefs (1975).

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Eggshell Thickness in American Shorebirds before and since DDT

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Morrison, Michael L. and Lloyd F. Kiff. 1979. Eggshell thickness in American shorebirds before and since DDT. Canadian Field-Naturalist 93(2): 187–190.

Thickness indices of eggshells collected before and since use of DDT began were obtained for 31 species and subspecies of American shorebirds. Little change in thickness was found between early and recent samples, the maximum being –4.7% in "American" Oystercatcher (*Haematopus ostralegus palliatus*) eggshells from Texas and the Atlantic coast of the United States.

Key Words: American shorebirds, eggshell thickness, DDT, bioaccumulation, pesticides, chemical pollutants.

Significant eggshell thinning has been documented in many species of wild birds in recent years, nearly all of it attributable to the effects of *p,p'*-DDE, a breakdown metabolite of DDT (Cooke 1973; Stickel 1975; Peakall 1975). Thinning has been most severe in the eggshells of bird- and fish-eating species (Ratcliffe 1970; Anderson and Hickey 1972), but there have been few investigations of eggshell thickness in middle trophic-level birds, including shorebirds of the suborder Charadrii. Minor shell thickness changes were found for *Pluvialis apricaria* and *Tringa nebularia* by Ratcliffe (1970), and for *Philohela minor* by Dilworth et al. (1972) and Kreitzer (1972).

Studies of organochlorine residues in shorebirds or their eggs are more numerous. Keith and Gruchy (1972) summarized data from several sources, and additional figures for body and egg residue levels have been reported for various species by Enderson and Berger (1968), Flickinger and King (1972), White et al. (1973), Peakall (1976), and Walker (1977). Owing to its importance as a game species, several studies are available on residue levels in American Woodcocks (*Philohela minor*) (Pearce 1971; McLane et al. 1971, 1973; Dilworth et al. 1972, 1974; Clark and McLane 1974).

Most of these studies indicated that organochlorine residues, including DDE, rarely exceeded 4 μg/g wet weight; however, significantly higher levels of DDE were found in the bodies of *Numenius americanus* (14.0 μg/g wet weight) in Alberta (Peakall 1976), *Philohela minor* (13.0 μg/g wet weight) in a heavily sprayed area in New Brunswick (Pearce 1971), *Pluvialis dominica* (62.0 μg/g lipid), and *Numenius phaeopus* (39.0 μg/g lipid) in Alaska (Walker 1977),

TABLE 1 — Shorebird eggshell thickness from various North American areas

Species, Region sampled	Early period (E)	Recent period (R)	No. of eggs[a] E	No. of eggs[a] R	Mean index ± SE E	Mean index ± SE R	% Change
Jacana spinosa, E. Mexico	1896 – 1923	1948 – 1965	56(13)	88(22)	0.76 ± 0.006	0.77 ± 0.004	+ 1.3
Haematopus ostralegus palliatus, Texas & U.S. Atlantic coast	1882 – 1946	1955 – 1969	51(20)	54(20)	1.49 ± 0.014	1.42 ± 0.010	– 4.7***
H. o. bachmani, U.S.Pacific coast	1892 – 1947	1949 – 1966	52(20)	34(13)	1.52 ± 0.014	1.47 ± 0.017	– 3.3***
Himantopus mexicanus, Utah	1898 – 1930	1959	68(17)	24(6)	1.06 ± 0.008	1.04 ± 0.015	– 1.9
Recurvirostra americana, California	1918 – 1944	1948 – 1972	77(20)	32(8)	1.11 ± 0.008	1.15 – 0.014	+ 3.6*
Pluvialis dominica, Alaska	1900 – 1945	1949 – 1968	68(17)	58(15)	0.82 ± 0.006	0.82 ± 0.006	
P. squatarola, Alaska	1924 – 1947	1948 – 1965	87(22)	96(25)	0.98 ± 0.004	1.00 ± 0.007	+ 2.0*
Charadrius semipalmatus, Manitoba	1931 1945	1948 1953	58(15)	26(8)	0.62 ± 0.006	0.61 ± 0.08	1.6*
C. wilsonia, Texas	1900 – 1941	1952 – 1965	46(16)	20(7)	0.84 ± 0.007	0.83 ± 0.007	– 1.2*
C. wilsonia, Florida	1906 – 1935	1951 – 1968	24(8)	27(9)	0.83 ± 0.007	0.85 ± 0.008	+ 2.4
C. vociferus, California	1910 – 1941	1948 – 1977	80(20)	47(14)	0.81 ± 0.007	0.79 ± 0.007	– 2.5*
C. alexandrinus, California	1926 – 1941	1948 – 1961	60(20)	21(7)	0.72 ± 0.005	0.73 ± 0.008	+ 1.4
Limosa fedoa, Alberta	1929 – 1947	1950 – 1969	65(17)	43(11)	1.24 ± 0.012	1.23 ± 0.007	– 0.8
Numenius phaeopus, Manitoba	1933 – 1945	1951 – 1953	80(20)	27(7)	1.05 ± 0.006	1.09 ± 0.011	+ 3.8**
N. americanus, Utah	1914 – 1947	1948 – 1958	77(21)	50(13)	1.45 ± 0.011	1.43 ± 0.014	– 1.4
Tringa solitaria, Alberta	1926 – 1946	1963 – 1967	48(12)	16(4)	0.64 ± 0.004	0.65 ± 0.012	+ 1.6
Catoptrophorus semipalmatus, Texas	1882 – 1941	1952 – 1968	77(20)	19(5)	1.12 ± 0.009	1.10 ± 0.009	– 1.8
Actitis macularia, California	1910 – 1937	1950 – 1966	68(18)	67(17)	0.64 ± 0.007	0.64 ± 0.005	-
Arenaria interpres, Alaska	1928 – 1947	1951 – 1965	68(17)	64(16)	0.73 ± 0.005	0.75 ± 0.008	+ 2.7*
A. melanocephala, Alaska	1924 – 1945	1951 – 1963	69(18)	63(16)	0.81 ± 0.005	0.80 ± 0.006	– 1.2
Phalaropus tricolor, California	1933 – 1946	1951 – 1972	79(20)	30(8)	0.72 ± 0.006	0.70 ± 0.010	– 2.8
P. lobatus, Alaska	1931 – 1945	1951 – 1963	70(18)	78(20)	0.54 ± 0.004	0.52 ± 0.004	– 3.7*
P. fulicarius, Alaska	1922 – 1946	1951 – 1963	75(20)	78(20)	0.54 ± 0.003	0.53 ± 0.004	– 1.9
Calidris pusilla, Alaska	1914 – 1947	1951 – 1961	99(26)	77(20)	0.46 ± 0.002	0.46 ± 0.004	+
C. mauri, Alaska	1924 1934	1951 1965	78(20)	72(20)	0.47 ± 0.003	0.46 ± 0.003	– 2.1*
C. minutilla, Manitoba	1932 1945	1948 1953	44(12)	43(12)	0.45 ± 0.005	0.44 ± 0.003	– 2.2
C. bairdi, Alaska	1922 – 1945	1960 – 1963	67(18)	16(5)	0.51 ± 0.003	0.50 ± 0.009	– 2.0
C. alpina, Alaska	1911 – 1947	1951 – 1965	71(18)	88(23)	0.58 ± 0.004	0.58 ± 0.004	+
Micropalama himantopus, Manitoba	1931 – 1945	1950 – 1970	79(20)	29(8)	0.57 ± 0.004	0.56 ± 0.004	– 1.8

[a]Number of clutches represented given in parenthesis.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, t-test.

and in the eggs of *Philohela minor* (14.9 μg/g wet weight) in New Brunswick (Dilworth et al. 1972). In a DDT-sprayed area around Churchill, Manitoba, the invertebrate prey of shorebirds contained DDE residues of 0.3 and 0.4 μg/g wet weight, and shorebirds there accummulated DDE residues of up to an average of 39.4 μg/g wet weight (Brown and Brown 1970).

The DDE residue levels reported in these latter studies were at least as high as those associated with serious eggshell thinning in certain raptors and fish-eating birds (Blus et al. 1974; Peakall 1976; Kiff et al., *in press*), yet there have been no reports of such changes in the eggshells of these or other shorebirds. This study was undertaken to determine whether significant changes in eggshell thickness of American shorebirds have occurred since the introduction of DDT in the mid-1940s.

Methods

Empty dry eggshells of charadriine shorebirds in the collection of the Western Foundation of Vertebrate Zoology were weighed to the nearest 0.001 g on a Mettler P120 balance, and their length and breadth were measured to the nearest 0.01 mm with Helios dial calipers. A shell thickness index (shell weight × 100/length × breadth) was calculated for each eggshell; such an index is correlated with actual eggshell thickness (Anderson and Hickey 1972). Eggs that were broken, that had blowholes greater than 3 mm in diameter, or that were collected in an advanced stage of incubation, were excluded from the analyses. The nomenclature and species sequence used here follows Morony et al. (1975).

Results

The mean thickness indices for pre-1947 (before-DDT) and post-1947 (since-DDT) North American shorebird eggshells are shown in Table 1. Seven species had slightly thicker eggshells in the recent samples, four showed no change, and 16 species had thinner eggshells in the post-1947 samples. Eggs of another species, *Charadrius wilsonia,* were thicker in Florida but thinner in Texas than pre-1947 indices. The maximum amount of difference between the pre- and post-1947 samples were –4.7% in the "American" Oystercatcher (*Haematopus ostralegus palliatus*) in Texas and along the southern Atlantic coast of the United States. Recent eggshells of the "black" Oystercatcher (*H. o. bachmani*) in California and Oregon were 3.3% thinner than the mean thickness of the pre-1947 sample.

Many shorebirds included in this study migrate and winter in South American countries where DDT is still intensively used. For comparative purposes, we also measured eggshells of three resident species of Chilean shorebirds of three different families (Table 2). As with the North American species, only minor changes were noted. The only statistically significant difference, –4.1%, was found in a plover, *Vanellus chilensis.*

Discussion

Eggshell thinning exceeding 20% has generally resulted in reproductive failure and population declines in the species involved (Keith and Gruchy 1972; Stickel 1975), but the biological significance of thinning less than 10% is not well understood (Faber and Hickey 1973). In this study, the maximum increase (+3.8%) was similar to the maximum decrease (–4.7%) in thickness index. Although statistically significant, these minor index changes are probably due to sampling artifacts (e.g., observer error, insufficient sample size, geographical variation), rather than pesticide effects. We know of no biological phenomena which could readily explain an increasing shell thickness within the span of time these eggs were collected.

Disruptions in eggshell ultrastructure and chemical composition that reduced egg hatchability in a population of Common Terns (*Sterna hirundo*) were attributed to DDE contamination even in the absence of marked shell thinning (Fox 1976). Thus, the lack of substantial thinning of American shorebird eggshells

TABLE 2 — Eggshell thickness of Chilean shorebirds

Species	Early period (E)	Recent period (R)	No. of eggs[a] E	No. of eggs[a] R	Mean index ± SE E	Mean index ± SE R	% Change
Nycticryphes semicollaris	1934 – 1938		28(15)		0.93 ± 0.011		
		1962 – 1969		19(11)		0.90 ± 0.013	– 3.2
Vanellus chilensis	1934 – 1941		24(8)		1.21 ± 0.017		
		1960 – 1968		33(10)		1.16 ± 0.011	– 4.1*
Gallinago paraguaiae	1933 – 1940		40(20)		0.87 ± 0.008		
		1957 – 1969		22(12)		0.88 ± 0.013	+ 1.1

[a]Number of clutches given in parentheses.
*$P < 0.05$.

in recent years does not prove that these species are free of pesticide-induced reproductive problems.

It is possible that shorebirds have a lower sensitivity to DDE-induced eggshell thinning than many higher trophic-level species, in addition to usually possessing lower residue burdens. Peakall (1975) categorized the charadriiforms as being "moderately sensitive" to DDE, based on data on Herring Gulls (*Larus argentatus*) presented in Hickey and Anderson (1968).

Although DDE residues in these species have evidently not reached a level at which they cause eggshell thinning, migrant shorebirds may still represent the most important source of DDE contamination for Arctic raptors, including Peregrine Falcons (*Falco peregrinus*) and Gyrfalcons (*F. rusticolus*). Several studies have indicated that migratory shorebirds possess the highest organochlorine residues of any prey item taken by these falcons (Cade et al. 1968; Enderson and Berger 1968; White et al. 1973; Walker 1977).

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Response of Wintering Moose to Mechanical Habitat Rehabilitation in Alaska

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Moose (*Alces alces gigas*) formed winter concentrations following mechanical crushing of vegetation in a 28-yr-old burn. Compared to a control area, the density of Moose and calf survival in the rehabilitated area were consistently higher in January–March 1975. Persistent large aggregations, although dynamic in nature, were related to the distribution of crushed mature hardwood stands because Moose fed on aspen bark. Observed differences between the two areas resulted from the provision of a concentrated, available, and nutritious food supply in combination with less severe snow conditions.

Key Words: Moose, *Alces alces gigas*, habitat, rehabilitation, aggregation, behavior.

In 1975, as part of efforts to manage habitat to stabilize a declining Moose population, Kenai National Moose Range (KNMR) staff used LeTourneau tree crushers to rehabilitate a portion of an area burned in 1947. An important result of the winter crushing of mature and regrowth vegetation was the immediate presence of large concentrations of Moose in the crushed area. My objectives in observing these concentrations were to compare the use of the area to that of a control area and to observe behavioral responses of Moose to the habitat disturbance.

Study Area

The Willow Lakes Rehabilitation Area (WLRA) is located in the KNMR in the northwestern portion of the Kenai Peninsula, Alaska, and is part of a large plain composed of flats, low ridges, hillocks, muskeg, and numerous small lakes. The particular area selected to be crushed could be easily reached from a road and the vegetation was considered representative of the 1947 burn. A 460-ha (1137-acre) doughnut-shaped area was crushed while the "doughnut hole" was scheduled for a later controlled burn.

Two areas were surveyed by use of fixed-wing aircraft: a 2330-ha (5750-acre) area which included crushed and uncrushed portions and a control area of similar size approximately 6 km away in the 1947 burn. Both areas included many lakes; the actual area used by Moose for feeding and bedding was roughly equivalent.

J. L. Oldemeyer, Denver Wildlife Research Center (unpublished data) has provided detailed information on the vegetation in the project area before and after crushing. In general, before crushing, islands of remnant mature White Spruce (*Picea glauca*)/ Trembling Aspen (*Populus tremuloides*)/ Paper Birch (*Betula papyrifera*) stands were interspersed with regrowth birch-spruce (*P. glauca* and *P. mariana*) stands.

Methods

Semi-monthly surveys of the WLRA and control area were flown from 2 December 1974 until 2 May 1975. I used information from these surveys to select suitable areas for viewing large concentrations of Moose. I conducted long (4–8 h) observations of large aggregations in the crushed area and noted all Moose in the general area on my way to and from specific off-road observation sites of aggregations. In addition, I conducted a daily road survey along the southern boundary of the project area. Owing to lack of accessibility, however, I made no attempt to observe Moose in the control area. Ground observations continued, weather permitting, from 14 February until 6 April 1975.

During long observation periods, I observed aggregations from natural blinds (e.g., a clump of birch trees on a nearby hill) approximately 200 m from the Moose. After allowing a period for the animals to resume undisturbed behavior after my arrival at the blind, I recorded data at 15-min intervals, noting the number of Moose visible from my vantage point, the number of Moose in aggregations, the general behavior of individual Moose (e.g., feeding vs. lying), and the presence of collared Moose (collared previously by the Alaska Department of Fish and Game). I also sketched the relative locations of individuals. Between these observations, I scanned the area frequently for movements, arrivals and departures in aggregations, and interactions.

Results

The WLRA received much more use than the control area. Aerial observations documented 1374 d of Moose use in the WLRA compared to 466 d in the control area. Observed densities ranged from 2.5 to 9.8 Moose per km^2 in the WLRA compared to 1.3 to 3.1 Moose per km^2 in the control area (Table 1). The higher densities in the crushed area built up between

TABLE 1—Comparison of Moose densities observed in the Willow Lakes Rehabilitation Area (WLRA) and the control area

Date of survey	Moose/km²	
	WLRA	Control
23 Dec./74	2.5	
24 Dec./74		3.1
10 Jan./75	6.3	2.1
20 Jan./75	7.0	2.7
5 Feb./75	6.3	2.0
20 Feb./75	9.8	2.6
6 Mar./75	7.5	1.6
14 Mar./75	6.2	2.1
1 Apr./75	7.8	2.4
18 Apr./75	4.2	1.3

early and mid-winter, then decreased in late winter, while the densities in the control area remained low throughout the winter.

Calf survival was much higher in the WLRA (Table 2). Cow–calf ratios ranged from 26 to 62 calves per 100 adults, compared with those in the control area, which decreased steadily from 36 calves per 100 adults to none by 18 April.

Ground observations in the WLRA documented an additional 324 d of use by Moose. Although groupings of one, two, or three Moose were commonly observed travelling or feeding in any portion of the area, all larger groups were observed in crushed mature hardwood stands. The animals initially consumed branches and twigs of birch and aspen trees. Concentrations persisted in these area for several days apparently to consume aspen bark from the downed mature trees. Based on a vegetation type map of the area, maximum densities within these crushed stands varied from 0.25 to 30 Moose per km³ (n = 34).

TABLE 2—Comparison of calves per 100 adults observed in the Willow Lakes Rehabilitation Area (WLRA) and the control area

Date of survey	Calves/100 adults	
	WLRA	Control
23 Dec./74	39	
24 Dec./74		36
10 Jan./75	52	23
20 Jan./75	31	28
5 Feb./75	34	13
20 Feb./75	28	13
6 Mar./75	37	24
14 Mar./75	27	11
1 Apr./75	31	4
18 Apr./75	62	0

Concentrations persisted but the aggregations themselves were extremely dynamic during the long observation periods. Repeated observations of collared Moose indicate that the individual length of stay was variable, ranging from 1 to 112 d, which suggests that considerable turnover occurred throughout the winter.

With the exception of cow–calf pairs, Moose rarely left or entered the stands in groups. Individuals rarely interacted even at high densities. Only three brief interactions occurred during 48.1 h of observation involving 405 Moose.

Discussion

The comparison of Moose densities within the WLRA and those in the control area demonstrates the rapid build-up of Moose following crushing and a prolonged use of the crushed area by many Moose. The observed mid-winter aggregations, although not notably larger than those observed in late-winter situations (Timofeeva 1967; Peek et al. 1974; Roseneau and Stern 1974), were extremely dense within the crushed mature hardwood stands.

The lowland winter range of the 1947 burn is generally considered poor winter range (Oldemeyer et al. 1978). Thus, it is likely that the major factor responsible for the aggregations and concentrations of Moose in the WLRA was a food supply that was highly nutritious (J. L. Oldemeyer, personal communication), concentrated, and available.

Snow conditions were also variable between the two areas. Movement of the large crushers to various sites compacted the snow into trails and the removal of vegetation resulted in wind compaction of newly-fallen snow. Sigman (1977) noted that the increasing snow depths in typical 1947 burn habitats, in the nearby Moose Research Center, appeared related to the timing of calf deaths. In the WLRA, the reduction of energy expenditure necessary to move through deep snow and to locate food was combined with an increased energy intake from the food supply. This combination may have acted to reverse some of the stressful effects of typical winter conditions and seemed to have benefitted calves in particular.

The immediate and prolonged use of the rehabilitated area demonstrates flexible aspects of Moose behavior patterns. Use of the disturbed area confirms the ability of individual Moose opportunistically to locate a small area where winter conditions are more favorable for survival and the ability of wintering Moose to tolerate high densities.

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New Localities for the Northern Spring Salamander and the Four-toed Salamander in Southwestern Quebec

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Gordon, David M. 1979. New localities for the Northern Spring Salamander and the Four-toed Salamander in southwestern Quebec. Canadian Field-Naturalist 93(2): 193–195.

New localities for the salamanders *Gyrinophilus porphyriticus porphyriticus* and *Hemidactylium scutatum* are documented and the habitat at the collecting sites described. This is the first record for *Gyrinophilus* west of the Richelieu River and only the second record outside the Appalachian Mountain region. *Hemidactylium* is reported for the second time south of the St. Lawrence River in Quebec.

Key Words: salamanders, *Gyrinophilus, Hemidactylium*, geographic distribution, Quebec.

The geographic distribution of salamanders in Quebec is poorly known (see Figure 1). The secretive nature and seasonally variable habits of these animals and, until recently, the lack of systematic field work have contributed to this situation. The recent efforts of the author in conjunction with the National Museum of Natural Sciences, and of Weller (1977) have expanded our knowledge of the nature of the distributions of two of the species of salamanders in Quebec. This note documents two new localities for the Northern Spring Salamander and one new locality for the Four-toed Salamander.

Gyrinophilus porphyriticus porphyriticus

During the course of field work (15 August 1973; 29 April and 19 May 1975) two larval and 10 metamorphosed Northern Spring Salamanders (*Gyrinophilus p. porphyriticus*) were discovered in the headwaters of Rivière aux Outardes-Est, near Franklin Centre, Huntingdon County (45°01′N, 73°54′W).

Rivière aux Outardes-Est originates at a swamp and small lake at the top of Covey Hill at an elevation of 210–225 m. At the collecting site the stream cuts through a stand of Eastern Hemlock (*Tsuga canadensis*) and mixed hardwoods of Sugar Maple (*Acer saccharum*), American Beech (*Fagus grandifolia*), and Yellow Birch (*Betula alleghaniensis*). The stream varies in width from 4 to 10 m, with steep banks ranging from 10 to 80 cm in height. The stream bottom consists of gravel and sand with some detritus; rocks of all shapes and sizes provide cover in the stream and along the banks. An extensive network of passages among the rocks occurs where the stream has eroded the bank.

The Northern Dusky Salamander (*Desmognathus fuscus fuscus*) occurs in the seepage areas along the

banks and the Northern Two-lined Salamander (*Eurycea bislineata bislineata*) is abundant throughout the stream. The Spotted Salamander (*Ambystoma maculatum*), the Blue-spotted Salamander (*Ambystoma laterale*), and the Red-backed Salamander (*Plethodon cinereus cinereus*) occur in the woods adjacent to the stream.

This is the first record of the Spring Salamander west of the Richelieu River, and only the second record of the species from outside of the Appalachian Mountain region of Quebec. Weller (1977) reported Spring Salamanders from Yamaska Mountain of the Monteregian Hills on the St. Lawrence Lowlands. More recently, he has taken four metamorphosed *Gyrinophilus* from one locality on Shefford Mountain (Figure 1) at the edge of the Appalachian Mountain range. The Dusky Salamander and the Two-lined Salamander were also found at this locality. These specimens and those I collected have been deposited in the herpetological collection of the National Museum of Natural Sciences as NMC 17816, and NMC 16379, 16767, 16791 respectively.

Hemidactylium scutatum

The Four-toed Salamander (*Hemidactylium scutatum*) has been reported from four scattered localities in Quebec of which only one is south of the St. Lawrence River (Figure 1). On 29 April 1976, two metamorphosed *Hemidactylium* were taken from a site 11 km E of Covey Hill, Huntingdon County, Quebec (45°01′N, 73°38′W).

The collecting area was a woodlot of Eastern Hemlock, Sugar Maple, American Beech, and Yellow Birch. The salamanders were discovered in a pile of bark at the base of a dead tree, close to a small woodland pond. Moss covering the rocks and logs, and bark and leaf litter provided cover. The ground was extremely wet with many scattered pools of

FIGURE 1. Solid circles depict localities for *Gyrinophilus p. porphyriticus* in Canada, triangles the known localities of *Hemidactylium scutatum* in Quebec. Locality 1, Franklin Centre *Gyrinophilus* record; 2, Shefford Mountain *Gyrinophilus* record; 3, the new record for *Hemidactylium*. The inset maps illustrate the North American ranges according to Conant (1975): A, *Gyrinophilus porphyriticus* and B, *Hemidactylium scutatum*.

temporary water. Sphagnum moss was present only in small widely scattered patches. This habitat is virtually identical to an area on Ile Perrot, Quebec where I have collected Four-toed Salamanders in past years, and to another Ile Perrot locality reported by McCoy and Durden (1965). Denman (1961, 1965) and Gorham (1955) found *Hemidactylium* in similar forest types. The Red-back Salamander and the Blue-spotted Salamander occurred in the immediate vicinity, and the Red-spotted Newt (*Notophthalmus viridescens*) was abundant in the nearby woodland pond.

This is the second record of *Hemidactylium* south of the St. Lawrence River in Quebec. The specimens are catalogued as NMC 17539.

My thanks go to Barbara L. Brown for her assistance in the field, to Wayne F. Weller who provided me with a copy of his manuscript on stream salamanders in advance of publication, and allowed me to publish his *Gyrinophilus* record, and to Francis R. Cook for his advice and encouragement regarding the field work and the manuscript. Portions of this study were financed by the National Museum of Natural Sciences, as part of a herpetofaunal survey in Quebec in 1975.

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First Record of the Long-tailed Shrew (*Sorex dispar*) in New Brunswick

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Kirkland, Gordon L., Jr., David F. Schmidt, and Carol J. Kirkland. 1979. First record of the Long-tailed Shrew (*Sorex dispar*) in New Brunswick. Canadian Field-Naturalist 93(2): 195–198.

One subadult male Long-tailed Shrew (*Sorex dispar*) was collected in Albert County, New Brunswick, on 25 July 1978. This is the first New Brunswick record for this species and the fifth Canadian specimen collected. The New Brunswick specimen was compared to *Sorex gaspensis* and New England *S. dispar* to ascertain its specific identity.

Key Words: *Sorex dispar*, Long-tailed Shrew, New Brunswick, first record, *Sorex gaspensis*.

The Long-tailed Shrew (*Sorex dispar*) is known from Canada on the basis of four specimens (American Museum of Natural History 174344–47) collected at two localities in Quebec near the United States border: 16 km (10 mi) S of Armstrong, near Lac du Portage; and south of Cartierville, just a few yards north of the New Hampshire border (Peterson 1966) (Figure 1). With the exception of these specimens which at present cannot be located for study, *S. dispar* is confined to the United States in the Appalachians and adjacent mountains in a narrow belt extending from Maine to North Carolina (Kirkland and Van Deusen 1979). The closely related Gaspé Shrew (*Sorex gaspensis*) is an endemic Canadian species which until recently was thought to be restricted to the Gaspé region of Quebec. But it has recently been collected in such disjunct locations as Mount Carleton, New Brunswick (Peterson and Symansky 1963) and Cape Breton Island, Nova Scotia (Roscoe and Majka 1976) (Figure 1). In an attempt to determine whether the hiatus in the distribution of *S. gaspensis* is real or the product of inadequate sampling, field work was conducted in southeastern New Brunswick and in the Cobequid Mountains and on North Mountain in

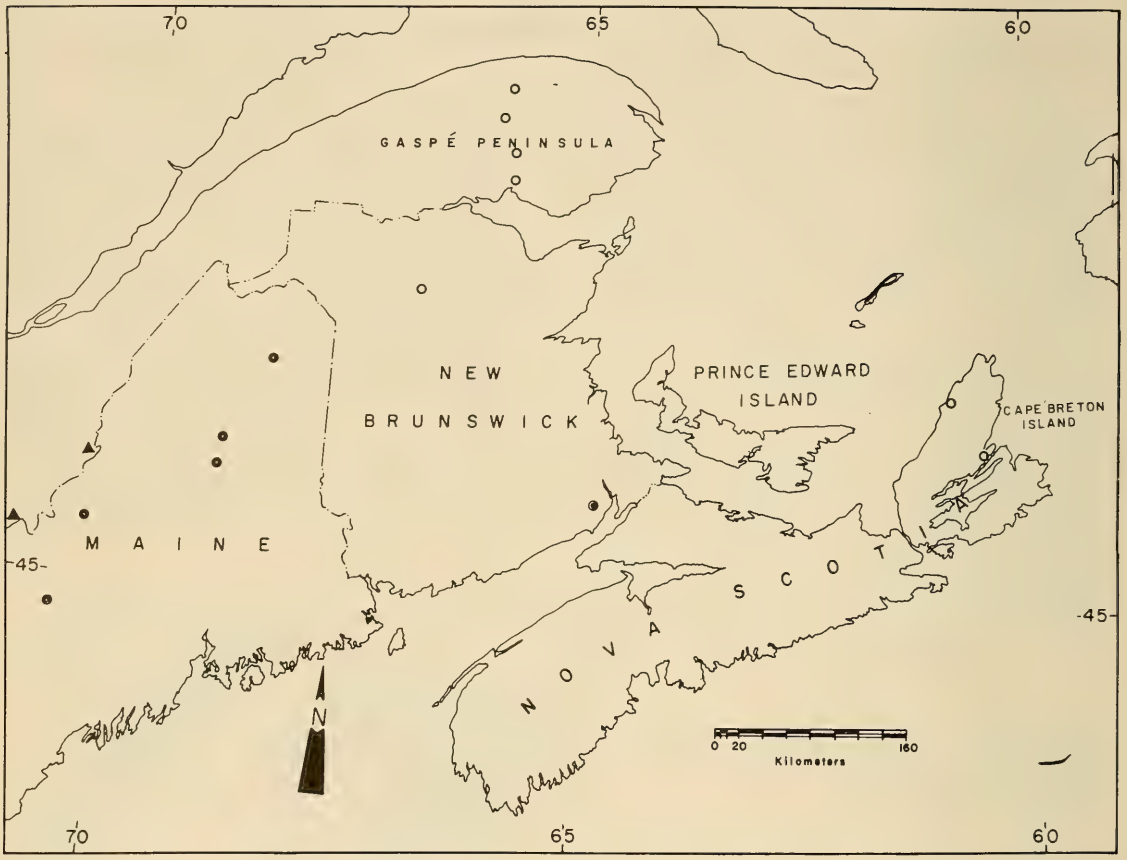

FIGURE 1. Location of capture sites of *Sorex gaspensis* (open circles), Maine *Sorex dispar* (dots), SSC 8393 (dot within circle), and previously recorded Quebec *S. dispar* (triangles), based on Godin (1977), Kirkland and Van Deusen (1979), and Peterson (1966). One mark may represent more than one locality if several specimens have been collected from different localities in the same region.

Nova Scotia during July 1978.

In 2057 trapnights (TN) of sampling effort at six localities in Nova Scotia and New Brunswick, no *S. gaspensis* were collected; however, on 25 July 1978, a single subadult male *S. dispar* was trapped 5.3 km N, 3.5 km W of Riverside-Albert, Albert County, New Brunswick. This locality is approximately 305 km ESE of the nearest previous locality for this species at Beaver Creek, Aroostook County, Maine (Godin 1977). The New Brunswick specimen (Shippensburg State College 8393) was captured in a Museum Special trap baited with rolled oats and set in rocks, 30 cm below the surface, on a rocky east-facing hillside in a deciduous-coniferous forest (elevation 180 m). The capture site was dominated by Yellow Birch (*Betula alleghaniensis*) with Mountain Maple (*Acer spicatum*) and Balsam Fir (*Abies balsamea*) as subdominants. Living ground cover at the site averaged 51–75% and consisted of mosses, ferns, and seedlings of Mountain Maple. In 306 TN of sampling effort, 23 small mammals representing six species were captured in the trapline that yielded the single *S. dispar:* seven Smoky Shrews (*Sorex fumeus*), four Short-tailed Shrews (*Blarina brevicauda*), one Northern Flying Squirrel (*Glaucomys sabrinus*), eight Southern Red-backed Voles (*Clethrionomys gapperi*), and two Woodland Jumping Mice (*Napaeozapus insignis*). The trap in which the *S. dispar* was captured had yielded a male *S. fumeus* the previous morning (24 July). The standard external measurements and 16 selected cranial and mandibular characters for specimen SSC 8393 are presented in Table 1.

Because the New Brunswick specimen was captured near the center of the disjunction in the range of *S. gaspensis* and over 300 km from the nearest *S. dispar*

TABLE 1—Measurements for six external and 16 cranial/mandibular characters of New Brunswick specimen SSC 8393 and the ranges of measurements for these 22 characters in 23 *S. gaspensis* and 56 New England *S. dispar* (All linear measurements in millimetres; weight in grams)

Character	SSC 8393	Range	
		S. gaspensis	*S. dispar*
Total length	123	95–127	103–136.5
Tail length	56	45– 55*	46– 61
Hind foot length	13	10.5 –12.5*	12– 15
Ear length	8	5– 9	5– 9
Body length	67	45–77	48– 79
Weight	4.2	2.2 – 4.3	4.0 – 4.9
Greatest length	17.85	15.7 –17.5*	17.3 –18.3
Condylobasal length	16.8	15.35–16.35*	16.45–17.7
Interorbital breadth	3.15	2.8 – 3.5	3.1 – 3.6
Cranial breadth	8.25	7.1 – 8.2*	7.5 – 8.3
Molariform tooth row	3.9	3.4 – 3.65*	3.75– 4.3
Cheek tooth row	4.55	4.05– 4.4*	4.1 – 4.9
Total tooth row	7.05	6.35– 7.25	6.8 – 7.6
Incisor width	1.15	1.0 – 1.3	1.1 – 1.4
Canine width	1.65	1.3 – 1.55*	1.4 – 1.8
Molar width	3.8	3.2 – 3.8	3.65– 4.15
Nasal length	6.25	5.4 – 6.3	5.6 – 7.25
Palatal length	7.25	6.0 – 6.75*	6.6 – 7.5
Post-palatal length	8.2	6.9 – 7.6*	7.3 – 8.35
Mandible length I	10.15	9.1 – 9.9*	9.75–10.75
Mandible length II	11.00	9.7 –10.8*	10.1 –11.35
Mandible height	3.2	2.95– 3.95	3.05– 4.0

*SSC 8393 exceeds range for character.

locality, it was important to ascertain its specific identity correctly. Was it a *S. dispar*, a *S. gaspensis*, or was it intermediate between these two taxa? The existence of an intergrade specimen at this New Brunswick locality would call into question the specific status of *S. gaspensis* (Kirkland and Van Deusen 1979).

Univariate and multivariate statistical analyses were performed to compare the New Brunswick specimen with 23 *S. gaspensis* and 56 New England *S. dispar*. For localities of these specimens and descriptions of the measurements see Kirkland and Van Deusen (1979). All skulls were measured by the senior author with Helios dial micrometers (calibration 0.05 mm) under a dissecting microscope.

Comparisons of the New Brunswick specimen with *S. gaspensis* and New England *S. dispar* revealed that the New Brunswick specimen exceeded the size range of *S. gaspensis* for 12 of 22 characters and equalled the largest known specimen for one other (Table 1). The New Brunswick specimen fell within the size range of New England *S. dispar* for all 22 characters (Table 1).

Data from 247 *S. dispar* with locality latitudes ranging from from 35.6° N (North Carolina) to 45.9° N (Maine) were analyzed with the SPSS Computer Package (Nie et al. 1975) to produce regression lines of size versus latitude for each of 22 characters. These regression equations were used to predict the characteristics of a *S. dispar* from the latitude of the New Brunswick specimen (45.8° N). The New Brunswick specimen fell within the 95% confidence interval of the predicted value (see Zar 1974) for 21 of 22 characters (Table 2). In addition, discriminant function analyses (BMD 07M, Dixon 1967) were performed on the New Brunswick specimen, 14 *S. gaspensis*, and 25 New England *S. dispar* using 18 characters. The New Brunswick specimen was assigned by the computer analysis to *S. dispar* both when assigned to *S. gaspensis* ($P = 0.753$) and to New England *S. dispar* ($P = 1.000$). The respective discriminant scores (first two canonical variables) for SSC 8393, the 14 *S. gaspensis*, and 25 *S. dispar* were $X = -0.358$, $Y = 1.010$; $\overline{X} = -2.965$ (range -4.179 to -1.395), $\overline{Y} = 0.000$ (range -1.956 to $+2.411$); $\overline{X} = 1.779$ (range -0.169 to $+3.479$), $\overline{Y} = -0.000$ (range -1.499 to $+1.788$) when SSC 8393 was assigned *a priori* to *S. gaspensis*, and $X = +3.415$, $Y = -0.010$; $\overline{X} = -4.402$ (range -5.944

TABLE 2—Comparisons of the observed values of 22 morphological variables in New Brunswick Long-tailed Shrew (*Sorex dispar*) specimen (SSC 8393) from 45.8°N with the predicted values and 95% confidence intervals of a *Sorex dispar* from that latitude based on regression analysis of 247 *S. dispar* collected at latitudes 35.6°–45.9°N

Character	SSC 8393	Predicted value	95% Confidence interval
Total length	123	115.92	103.76–128.08
Tail length	56	54.68	49.02– 60.34
Hind foot length	13	13.06	11.51– 14.61
Ear length	8	7.54	4.51– 10.57
Body length	67	61.35	50.56– 72.14
Weight	4.2	4.37	2.71– 6.03
Greatest length	17.85	18.02	17.34– 18.70
Condylobasal length	16.8	16.97	16.23– 17.71
Interorbital breadth	3.15	3.47	3.13– 3.81
Cranial breadth	8.25	7.87	7.37– 8.37
Molariform tooth row	3.90	4.07	3.87– 4.27
Cheek tooth row	4.55	4.46	4.22– 4.70
Total tooth row	7.05	7.30	6.98– 7.62
Incisor width	1.15	1.36	1.22– 1.50
Canine width	1.65	1.51	1.33– 1.69
Molar width	3.80	3.89	3.61– 4.17
Nasal length	6.25	6.20	5.62– 6.78
Palatal length	7.25	7.04	6.64– 7.44
Post-palatal length	8.20	7.94	7.46– 8.42
Mandible length I	10.15	10.08	9.66– 10.50
Mandible length II	11.00	11.01	10.49– 11.53
Mandible height	3.20	3.50	3.12– 3.88

to −2.916), $\overline{Y}$ = −0.000 (range −1.708 to +1.595); $\overline{X}$ = +2.371 (range −0.633 to +4.744), $\overline{Y}$ = −0.000 (range −2.226 to +1.901) when SSC 8393 was assigned *a priori* to *S. dispar*.

The results of these three analyses suggest that the New Brunswick specimen is a *Sorex dispar* and resembles *S. dispar* from New England.

Acknowledgments

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Intraspecific Food Theft by the American Kestrel

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Fetterolf, P. M. 1979. Intraspecific food theft by the American Kestrel. Canadian Field-Naturalist 93(2): 198.

One male American Kestrel, *Falco sparverius*, was observed in an unsuccessful attempt to steal prey from another male American Kestrel.

Key Words: American Kestrel, prey theft, *Falco sparverius*.

On 24 March 1978, I watched two male American Kestrels, *Falco sparverius*, at the southern edge of the Toronto Island Airport, Toronto, Ontario. The weather was cold (+3°C) and clear. The birds, perched approximately 5 m apart in 15- to 20-m willows, *Salix rigida*, faced the open grassland to the north. At 12:02 EST, one kestrel plunged from its perch and captured a rodent, probably a vole, *Microtus* sp. The bird did not mantle its prey, whereupon the second male swooped down from its perch, grabbed the vole, and rapidly flew north low across the airport runways. The victim took flight immediately, climbed above the robber and dove upon it three times, shrieking the "klee" call just prior to contact each time. At each contact, the pursurer apparently dug its talons into the fleeing bird. On the third assault, the robber dropped the rodent and departed. The other kestrel pounced on the prey at once, assumed an exaggerated mantling posture with the wingtips nearly touching, and ate the rodent. The theft, chase, and successful recapture of the prey took less than 90 s and covered a distance of about 40 m.

No reports of prey theft by American Kestrels were found but a European Kestrel, *F. tinnuculus*, robbed prey from a Short-eared Owl, *Asio flammeus* (Boyle, G. L. 1974. Kestrel taking prey from Short-eared Owl. British Birds 67: 474–475). Prey-robbing by kestrels seems to be rare, but it is not surprising that the observed encounter occurred at a time of the year when food supplies were likely to be low.

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First Record of the Northern Brook Lamprey, *Ichthyomyzon fossor*, in the Nelson River Drainage, Manitoba

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Jyrkkanen, J. and D. G. Wright. 1979. First record of the Northern Brook Lamprey, *Ichthyomyzon fossor*, in the Nelson River drainage, Manitoba. Canadian Field-Naturalist 93(2): 199–200.

Fourteen specimens of Northern Brook Lamprey, *Ichthyomyzon fossor*, were collected from the Birch River, a tributary to the Winnipeg River in southeastern Manitoba on 8 and 13 May 1977. This represents the first record of this species in the Nelson River drainage and is a significant extension of the presently known range.

Key Words: *Ichthyomyzon fossor*, range extension, Nelson River drainage, Manitoba, new records, geographical distribution.

Fourteen specimens of Northern Brook Lamprey, *Ichthyomyzon fossor*, were captured by hand from the Birch River, upstream of the town of Prawda, Manitoba (49°39′N, 95°48′W) on 8 and 13 May 1977. The Birch River is a tributary of the Winnipeg River, in the Nelson River system, flowing into Hudson Bay. This represents the first record of this species in the Nelson River drainage system and is significant in that it is a range extension of over 500 km from the nearest known population.

Identification of the specimens was confirmed by E. J. Crossman of the Royal Ontario Museum. Morphological characteristics on which species identification is based are as follows: lateral teeth all unicuspid; the supraoral lamina a single bicuspid tooth; infraoral lamina cusps blunt; diameter of the sucking disc less than one half the length of the branchial region; myotomes in the trunk, between the last gill opening and the anus, number between 49 and 54; total length of mature individuals between 100 and 255 mm. The specimens have been deposited in the collection of the Royal Ontario Museum, Toronto and are catalogued under the number ROM 34264. Of the 14 specimens collected, 10 were males, averaging 116.5 mm (SE = 3.6 mm), and four were females, averaging 136.5 mm (SE = 9.6 mm) in total length. All specimens were sexually mature with females having free ova within the body cavity. It is assumed that they were spawning at the time of collection.

Ichthyomyzon fossor is currently known to exist over a very limited range. Hubbs and Trautman (1937) report that the species is abundant in all of the Great Lakes drainages of the State of Michigan (Erie, Huron, Michigan, and Superior) and from Scott Creek in the Mississippi River drainage of Wisconsin. Leach (1940) reports the occurrence of the species in the Tippecanoe River (Mississippi River drainage) in northern Indiana. Dymond (1947) indicates that *I. fossor* was resident in the Thames River system, while Vladykov (1949) reports that specimens were collected in the Yamaska and St. Francis rivers of southern Quebec. Scott and Crossman (1973) add that the distribution of the species includes Georgian Bay, Lake Nipissing, and the north shore tributaries of Lake Superior.

The Birch River is a small, fairly slow-moving river with an estimated maximum flow of 5.7–8.5 m^3/s (200–300 ft^3/s) and a low flow of less than 0.15 m^3/s (5 ft^3/s). Winter flows may be augmented by overflow from the Shoal Lake viaduct entering the upper reaches of the Birch River at East Braintree. The substrate of the Birch River is highly varied with silty sediments in the quieter reaches of the stream, gravel and cobble riffles, bedrock outcroppings, and several small waterfalls. A thick mat of algae covers the shallow, rocky substrates in the summer.

Hubbs and Trautman (1937) state that *I. fossor* lives in creeks and small rivers, apparently avoiding both small brooks and large rivers. It has never been recorded in lakes, either small or large. This would seem to preclude the hypothesis that the Birch River population has been derived from either Lake Superior or Wisconsin populations. Vladykov (1949) reports that ammocoetes of *I. fossor* are sold as bait for sport fishing in Quebec. This statement tends to support a hypothesis that the Birch River population may have been introduced by an angler who discarded his remaining bait after a fishing trip.

Because the species is not parasitic, the presence of *I. fossor* in the Nelson River drainage basin should not present any possibility of endangering or destroying native fishes.

Acknowledgments

The authors acknowledge the assistance of D. P. Scott, Fisheries and Oceans, Winnipeg, C. C. Lindsey, Department of Zoology, University of Manitoba, Winnipeg, and E. J. Crossman, Curator of Ichthyology and Herpetology, Royal Ontario Museum, Toronto, in confirming the identification of the specimens, and thank W. Coder and J. Johnson, Manitoba Department of Renewable Resources, Hadashville, for their assistance in the field.

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Accepted 12 January 1979

Blue Grouse Brood Hen – Black Bear Confrontation

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Sullivan, M. G. 1979. Blue Grouse brood hen – Black Bear confrontation. Canadian Field-Naturalist 93(2): 200.

On 14 July 1977, while engaged in a census of Blue Grouse *(Dendragapus obscurus)* near Courtenay, Vancouver Island, British Columbia, I heard a banded female grouse clucking loudly (indicative of brood disturbance) as I approached the area. From about 75 m away I observed the grouse flying at a Black Bear *(Ursus americanus)*. Flaring about a metre from the bear, the hen then landed on the ground about 20 m away, clucking and rushing about. The bear ran towards the grouse, whereupon she flew at the bear and again landed some distance away. Through these maneuvers, the hen seemed to lead the bear out of a marshy valley onto a rocky ridge. At this point, the bear appeared to catch my scent and ambled out of sight. The hen then returned to the marshy area. Although no chicks were found, I later discovered that this hen had a brood at that time. Her behavior was similar to that displayed towards humans when chicks are present.

Searching the area, I found several stumps that had been freshly torn apart by a bear searching for insects. Ripe Huckleberries *(Vaccinium ovalifolium)* were plentiful and are an important food for bears in this area (unpublished data). Thus, a food shortage was unlikely at the time.

An interesting addition to this incident is that on 31 May 1977, I had found a leg band from an adult male Blue Grouse in a month-old bear scat in the same general area. This bird was banded as an adult on 16 June 1975, about 2.4 km from where the band was found and may have been eaten as carrion.

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News and Comment

Editor's Report for 1978

The Canadian Field-Naturalist received 149 manuscripts for consideration in 1978. This number is consistent with the 147 submitted in 1976 and the 137 in 1977.

In 1978, 77 papers (38 Articles and 39 Notes) originally submitted from 1975 to 1978 were published in Volume 92 of *The Canadian Field-Naturalist*. The breakdown according to subject matter is as follows: birds, 25; mammals, 23; plants, 17; invertebrates, 5; amphibians and reptiles, 4; fishes, 2; and other, 1. Comparison with the number of manuscripts published in the two previous years, 124 (34 Articles and 90 Notes) in 1976 and 101 (30 Articles and 71 Notes) in 1977, shows that the number of Notes published in 1978 was considerably lower. No explanation is apparent for this; certainly there have been no particular delays in the publication process nor any changes in acceptance criteria.

Occasionally there is a long lapse after a manuscript has been returned to its authors for revision and before it is resubmitted and accepted for publication. In fact, this interval has even exceeded three years! Therefore, the proportions of accepted papers with respect to the years in which they were submitted (number accepted/number received) have increased over the earlier published figures. The revised proportions are as follows: 1974 — 116/152; 1975 — 122/167; 1976 — 90/147; and so far for 1977 — 86/137.

The financial position of *The Canadian Field-Naturalist* is currently good because several authors have paid page charges for all published pages rather than just the obligatory charges for pages over six. Therefore, for the first time in several years, it was not necessary to submit an application for a grant to the Natural Sciences and Engineering Research Council (formerly the granting body was the National Research Council of Canada). Furthermore, our printer, M.O.M. Printing of Ottawa, has tried to keep our printing costs down while at the same time continuing to put out a quality product. The financial outlook then for 1979 is conditionally bright.

LORRAINE C. SMITH
Editor

Proposals Invited from Field Research Investigators

The Center for Field Research, a non-profit organization established to raise private funds for field research and to encourage public understanding of science, is currently accepting proposals for 1980. Projects are considered on the basis of scientific merit and their ability to utilize the assistance of motivated lay volunteers in the field.

In the past seven years, The Center for Field Research and its affiliate, Earthwatch, have raised over $1.5 million from interested members of the public who have also contributed their time and skills to worthy research in a wide variety of disciplines. This year, it expects to grant another $500,000 in support of 66 projects, including the observation of sea cow distribution and behavior, western Australia; a study of the ecology and social behavior of the spotted hyena, Kenya; an archaeological and architectural investigation of Repton Anglo-Saxon church, England; an anthropological study of returning migrants, Newfoundland; a paleontological survey and fossil collection of Devonian rocks, Idaho; and an archaeological study of early Iron Age settlement and economic systems, West Germany.

Proposal deadlines for 1980 research are: 1 June 1979 (for work beginning after 1 December 1979); 1 October 1979 (for work beginning after 1 June 1980); and 15 January 1980 (for work beginning after 1 September 1980). Scholars of all nationalities and from all disciplines are invited to apply. For application guidelines write *Nancy Bell Scott, The Center for Field Research, 10 Juniper Road, Box 127-Q, Belmont, Massachusetts 02178 (Phone 617-489-3032).*

Inland Bird Banding

This journal, formerly *Inland Bird Banding News*, published by the Inland Bird Banding Association and printed by Allen Press, has been drastically changed by its new Editor. It is now a quarterly refereed journal and will no longer contain the news and other columns that it once had. These items will continue in some form in a newsletter.

The Editor is actively soliciting manuscripts that deal with bird-banding techniques and the results of bird-banding studies, especially studies dealing with birds from middle North America (Canada to the Gulf Coast). Interested ornithologists and students of birds who have suitable material for publication (preferably manuscripts of 10 pages or less in length) should contact the Editor, *Jerome A. Jackson, Department of Biological Sciences, Mississippi State University, Mississippi State, Mississippi 39762 (phone 601-325-5722).*

Bluebird Society

A new society, the Bluebird Society of North America, has been formed. Its address is as follows: Box 6295, Silver Springs, Maryland 20906.

We thank Colleen Hislop for correcting the page proofs for this issue.

Book Reviews

ZOOLOGY

Where to Find Birds in British Columbia

By David M. Mark. 1978. Kestrel Press, New Westminster. 72 pp., illus. Paper $3.00. (Available by mail from Kestrel Press, P.O. Box 2054, New Westminster, British Columbia V3L 5A3.)

This small book (13.5 × 21 cm) gives bird-finding information for 49 areas ("sites") in British Columbia (hereafter B.C.), which are described, region by region, for eight geographic regions of the province. A sketch map shows the general locations of birding areas in each region, but the reader will need a good road map to use with the book. The introduction (six pages) includes a helpful discussion of bird distribution in B.C. as related to the Biotic Areas of Munro and Cowan (B.C. Provincial Museum Special Publication 2, 1947). Following this, eight pages are occupied by a photocopy of the recent (1977), comprehensive checklist of B.C. birds issued by the Provincial Museum, which identifies those species known to breed in B.C. and those of accidental occurrence. The main part of the book (pages 19 to 63) is devoted to area accounts, which vary in length from five lines to two pages. These are generally up-to-date and informative, with specific and accurate route directions, including distances (the author is a geographer!), and usually with lists of particular bird species to expect. Finally, there is a seven-page section on "sought-after species" (those most often sought by birders), with references to area accounts and sometimes additional comments as well. Besides the author, 15 other individuals or groups contributed information for the book.

My only major criticism of this guide is that coverage is poor for some parts of B.C. (As I was one of the contributors, I am perhaps indicting myself for not providing more information!) For example, Vancouver Island (and the Victoria area in particular) receives rather scanty treatment considering its diverse avifauna and the heavy visitation it receives from out-of-province birders. None of the five national parks in B.C. is mentioned. On the other hand, coverage is quite good for the Vancouver area and most of the southern interior, and the accounts included for those areas can scarcely be faulted. I sincerely hope the gaps in coverage will be filled in a future edition.

All in all, this is a very good bird-finding guide, at least for a pioneering effort in a province previously lacking one. It will prove very helpful both to B.C. birders and to those visiting the province from elsewhere.

WAYNE C. WEBER

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The Moths of America North of Mexico, Including Greenland. Fascicle 22.2, Noctuoidea (in part): Lymantriidae

By D.C. Ferguson. 1978. Classey and the Wedge Entomological Research Foundation (distributed in North America by Entomological Reprint Specialists, Los Angeles). US $48 ($40 by subscription).

This fascicle, often advertized as soon appearing, finally did. It was eagerly awaited by all who will have to use it. We have to admit that the Lymantriidae are a very difficult family and many things had to be elucidated to make publication useful: names, distribution, and general considerations.

This begins with the family name, and everybody concerned is glad that there were no changes in this as well as in often used generic names. These have been not quite stable in the past because of international faunal and taxonomic complications, like *Gynaephora, Dasychira, Lymantria, Leucoma, Euproctis.* Appreciable conservatism is also shown in specific names, e.g., *Euproctis chrysorrhoea.* One may hope that this final nomenclature finds easy access into our collections and papers.

One might question whether it was necessary to fill the literature with all the new "subspecific" names. More biochemical and larval taxonomic research would probably have obliterated some of the "subspecies" and shown them to be species in their own right. Here is certainly a field open for further research.

The keys are in general good, short, useful and working. The larval key to the last instar larvae of *Orgyia*, however, leaves a question open: how can there be a description of a larva of a "subspecies" when the so called "type" of this "subspecies" is as questionable as can be ("*leucostigma plagiata*") and the larvae in question just do not yield adults like this "type"? Otherwise this key is helpful and correct.

Certainly the most difficult genus is *Dasychira.*

Here Ferguson, who was especially involved for decades with this genus, can proudly show the fruits of long labor. The explications about the generic name now make *Dasychira* finally definite for our species, and we have to congratulate Ferguson for his success in re-finding *D. tephra*. From this point of departure everything else falls into place. We are also thankful that he was able to confirm and give new meaning to the names and taxa so familiar to all of us but so often doubted by overzealous workers over many years. I mean *obliquata, cinnamomea, atrivenosa, meridionalis, basiflava, leucophaea, dorsipennata, plagiata, grisefacta*. Other names like *aridensis, parallela, lemmeri, pini* disappeared after having been the reason for much misunderstanding in the past.

The other difficult genus in the family is *Orgyia*. Regrettably one cannot say what we just said about *Dasychira* in this case. There are many needless mistakes in Ferguson's treatment. There are also good points, and these are the following:

(*a*) the confirmation of the fact that all North American species belong to one only well-defined genus, *Orgyia*;

(*b*) the confirmation of *O. cana* as species in its own right. This, however, is not a "revised status," as it was already treated as such in Entomologische Zeitschrift 83: 12, i.e., in 1973, a publication which is left out of the literature quoted. The problem with the association of the larvae in this group would have been completely and easily solved if Ferguson had used the preserved and associated specimens of the McFarland rearings in the Los Angeles County Museum of Natural History. It has to be pointed out again that MONA authors seem to rely too exclusively on the collections of the United States National Museum, as already Rindge objected in Journal of the Lepidopteran Society 28: 4;

(*c*) giving taxonomic status to these puzzling very large California *Orgyia (magna)*. Further research is here very much necessary;

(*d*) the detection of the old Boisduval specimen which Guérin-Méneville figured and used for the name of *O. detrita*, in the collection of the United States National Museum. It should be remarked that "Degens Bd. Am. B." is not "apparently . . . an unpublished name" but is Latin for "coming from Boisduval America Borealis" (the Latin verb is dego, -i, -ere);

(*e*) the additional knowledge about *O. falcata* and its larva.

On the negative side there have to be mentioned the following points:

(*a*) the laconic statement "the female genitalia have not been studied." Besides the fact that they have been very extensively studied in several issues of Entomogische Zeitschrift and are especially in the genus *Orgyia* of decisive taxonomic importance, in a "definite" presentation of North American moths, this is not quite understandable;

(*b*) the omission of all observations about pupae is likewise not quite understandable, the more so as the form of the pupa is also species characteristic;

(*c*) the omission of any study of the eggs by means of the scanning electron microscope (SEM) and electrophoresis and also of all important larval characters, as mandibles, ocelli, setae on thoracic legs, headcapsules, surface of exterior cuticle;

(*d*) the claiming of a "new synonymy" for *O. definita kendelli* on p. 75 while this synonymy was long established in Entomologische Zeitschrift 83: 14 (*Definita kendelli* = *leucographa*), i.e., in 1973;

(*e*) the establishing of "new status" in the *rindgei/leuschneri* complex while Chua et al. had already established and published in Journal of Research on the Lepidoptera 15: 4 (1976) specific status for *O. rindgei*. This has been also repeated by Riotte in Entomologische Zeitschrift 87: 3 (1977).

Some special words have to be said on the "enfant terrible" of the whole fascicle: *O. leucostigma*. Looked at as Ferguson presents it, it well makes sense. The fact, however, is that the realities are quite other: (*a*) The aedoeagus which is said "may be at once distinguished from all other species in that it is apically tapered to a point" is blunt and not tapered to a point as SEM micrographs show. (*b*) The (not studied) female genitalia would have helped to an other and correct classification. (*c*) Use of the earlier published results of egg electrophoresis would have shown that indeed *leucostigma* is sympatric to the extreme with *wardi* which in no way is a "subspecies" or "synonym" of anything. (*d*) Larval structures, if they had been used, would have shown the same (they also were previously published). (*e*) To use the so called "Walker type" of *Acypha plagiata*, abdomenless as it is and without any locality label, as type for a "subspecies" of *leucostigma* in Nova Scotia, replacing *wardi*, is at best absurd. Insect pins may be convincing sometimes; in a case like this, certainly not. The Walker specimen could be used for the real *leucostigma* in Nova Scotia but I can see no need for this. Competent workers in the British Museum came to a quite other evaluation of the Walker specimen and placed it together with *leucostigma* from Wisconsin as best match. Therefore, one should list the Walker type as "incertae sedis." One good thing at least should be mentioned, however: with Abbot's larval painting of *leucostigma* declared as lectotype of the species, we have now a good basis for it. We also think that the male figure of Abbot's *leucostigma* is really *definita* (many of Abbot's plates are mixed with non-conspecific creatures). Very good also is Ferguson's final clearing up of the *leucographa* Geyer problem; we have nothing against his treatment here.

The plates in this volume are of the expected quality and with the richness of depicted specimens very useful. The only thing we miss is a single specimen of *Orgyia wardi* from the type locality, Prospect Road, N.S., perhaps best together with a *leucostigma* from the same locality to show the difference. The Nova Scotia specimens figured are all *leucostigma*.

In the literature quoted we miss the important paper by Chua et al., 1976, Investigation of selected species of the genus *Orgyia* (Lymantriidae) using isoelectrofocusing in thin layer polyacrylamide gel (Journal of Research on the Lepidoptera 15(4): 215–224) as well as Riotte, 1973, Uber *Orgyia (O.) gulosa* und *Orgyia (O.) cana* (Lep.: Lymantriidae) (Entomologische Zeitschrift 83(12): 129–140) and by the same author, 1977, Abschliessende Bemerkungen zu den Studien über nordamerikanische Arten der Gattung *Orgyia* (Lepidoptera: Lymantriidae) (Entomologische Zeitschrift 87(3): 9–12, concerning *definita, rindgei,* and *leucographa* = *detrita*).

The criticisms, however, do not interfere with the great value of the fascicle otherwise. We certainly welcome its final appearance and wish it good and longlasting success.

J. C. E. RIOTTE

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Hawks, Falcons and Falconry

By Frank L. Beebe. 1976. Hancock House, Saanichton, British Columbia. 320 pp., illus. $12.95.

Any author attempting to write an original book on birds of prey or falconry today, faces a difficult task, but Beebe certainly does offer something new in this most recent book. Perhaps the book should be retitled "Hawks, Falcons, Falconry and Human Attitudes"; through the entire book, there pervades an undertone of bitterness towards an anti-falconry movement, which culminates in the final chapter, "The endangering of the Peregrine: A study in environmental strategy." A reader cannot help but be impressed by the collection of facts which, according to the author, led to classifying the Peregrine Falcon as an endangered species. After seven years of intense involvement with birds of prey and their human admirers, be they scientists, bird-watchers, falconers, photographers, or others, I find it difficult to believe that these facts constitute a case for the premeditated abolition of falconry.

Biologists will be disappointed by the rather brief treatment of general raptor biology but Beebe demonstrates a good grasp of raptor behavior. His observations and theory on the adaptive significance of a reversible hallux, prone sleeping position, and very deep sleep associated with Arctic-nesting Gyrfalcons (p. 167) is interesting and certainly warrants further investigation. On p. 180, the author provides some fascinating insight into the influence of geographical landforms on hunting strategies of river-nesting Peregrine Falcons.

The descriptions for each species covered in the book are fairly standard, but tend to lean toward the western areas of Canada with which the author is clearly most familiar. Much, if not all, of this material has been reproduced from his earlier published work "Field studies of the Falconiformes of British Columbia," No. 17 Occasional Paper Series, British Columbia Provincial Museum. The author is somewhat inconsistent in his descriptions of the various subspecies, providing them for some species, but not for others.

The section on falconry techniques should prove extremely useful to falconers, as Beebe has chosen to present detailed accounts of certain aspects of this art rather than give a shallow description of falconry as a whole. For example, he has given a thorough description of how to fly a bird to the lure (p. 239).

Having conducted research on kestrel reproduction, I must dispute the author's statements regarding the timing of the breeding for this species (p. 132). Beebe claims that "kestrels arrive on their breeding territories in April" and that "eggs are produced, depending on latitude, from late May to mid-June." In southern Quebec at least, kestrels generally arrive as early as the latter half of March and lay eggs during the last two weeks of April and the first two weeks of May, somewhat dependent on weather conditions from year to year. Furthermore, my studies and those of others (Bent, A. C. 1938. Life histories of North American birds of prey. Part 2: Orders Falconiformes and Strigiformes. Dover Publications, New York. 482 pp.; Balgooyen, T. G. 1976. Behavior and ecology of the American Kestrel (*Falco sparverius*) in the Sierra Nevada of California. University of California Publications in Zoology 103: 1–83), give an average egg size of kestrels as approximately 35 × 28 mm rather than the 39 × 29 mm Beebe reported.

The first-year mortality rate of 90% quoted in this book for birds of prey on p. 207 is surely the highest ever reported in the literature. Also, this reviewer was

not aware that the seal hunt had been closed (see p. 298).

There is much unnecessary repetition in photographs and an overabundance of head studies, some of very poor quality, e.g., Peale's Falcon, p. 170. The ink drawings, with some exceptions, are quite well done, as well as functional. The flight silhouettes throughout the book are excellent. One illustration, that of a falconer's knot, is apparently missing on p. 193, and on p. 239 the labels on the two diagrams apparently have been assigned incorrectly.

These latter two errors exemplify the poor editing found throughout the book. More than 50 typographical and spelling errors were located in the text and there was inconsistent use of names, i.e., kestrel versus sparrowhawk, and even spelling, i.e., grey versus gray. References were not presented in a consistent manner and sometimes are incorrect, e.g., Morlan W. Nelson (1965), p. 152. Much space is occupied by overly emphatic titles in the first nine sections where only brief treatment of the subjects follows.

There is no doubt that Beebe has had much experience with both wild and captive birds of prey and for this reason, I am more inclined to recommend his other book, "Field studies of the Falconiformes of British Columbia" for raptor enthusiasts not especially interested in falconry. Falconers from coast to coast, however, will likely applaud Beebe's efforts in this book to speak on their behalf and it is to this audience that I heartily recommend this book.

DAVID M. BIRD

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Fishes of the World

By J. S. Nelson. 1976. Wiley, New York. xiii + 416 pp., illus. US $26.00.

The author wrote this book "to present a modern introductory systematic treatment of all major fish groups." It is intended to serve as a reference for professionals and as a text for fish systematics courses. This book, therefore, was doomed to failure before it was written, and ensured of success before it was off the press. Fish systematics is in a state of rapid change and the healthy diversity of opinion on various aspects of fish systematics assures that some of the included material is outdated, but the need for any recent synthesis is obvious to anyone trying to teach the subject.

Following the prefatory remarks, the text includes an Introduction which comments on numbers of fishes, their diversity, distribution, and classificatory schemes. Then follows a classification of the phylum Chordata in which fishes are treated to at least the familial level. Appendix I is a checklist of extant classes, orders, suborders, and families. Appendix 2 is a series of 45 distribution maps of families of fishes. There is an extensive bibliography and the Index includes the genera mentioned in the text.

Nelson considers six classes of fishes (four extant) comprising 46 orders and 450 families. An outline drawing of a "typical" representative of each of most families is included. Characteristics for each included family or higher taxon are usually included, although they are not always complete. Recent revisionary papers on the orders are mentioned and comparisons with previous classificatory syntheses are included. The number of genera and approximate number of species in each order and family are given, and in some cases these taxa are mentioned.

There are, of course, the inevitable minor errors: e.g., there is only one species of *Zanclus*, not two; *Terapon* is misspelled *Therapon*; and a few of more consequence, e.g., the retention of the families Rosauridae and Kasidorodae. For a volume of its size and complexity of nomenclature, there are remarkably few typographical errors and the references to literature through 1973 are quite complete. Inevitably this reference will be compared to the recent book by Lindberg which, unfortunately, in the English translation has the same title. The two books complement one another: Nelson's classification is more modern, has some distribution maps, and costs less than Lindberg's, which has better illustrations, a more extensive list of references and, of course, keys to families.

By and large Nelson has achieved what he set out to do, and despite differences of opinion one may have with the classification he uses or the philosophy by which he arrived at it, this is a most useful text. I recommend it highly to all serious students of fishes.

C. GRUCHY

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Nesting Ecology of Canada Geese in the Hudson Bay Lowlands of Ontario: evolution and population regulation

By Dennis G. Raveling and Harry G. Lumsden. 1977. Ontario Fish and Wildlife Research Report Number 98. Ontario Government Bookstore, Toronto. v + 77 pp. $3.50.

The report is divided into two major sections, nesting ecology and population limitations. Objectives for the study of the nesting ecology of Canada Geese of the Mississippi Valley Population were to examine apparent optimum and accomplished reproductive rates, habitat preferences, and density and spacing of nests in relation to the regulation of population size. The primary objective for the second portion of this report was to examine nesting ecology to provide insight into the factors limiting goose numbers. These objectives have certainly been fulfilled. The study has direct management implications and extends our understanding of the evolution of waterfowl adaptations to their environment.

The 159-square-mile study area located west of James Bay was examined intensively, by walking and helicopter searches, in 1967–1969 for nesting geese. The researchers were fortunate in having a "late" year, an "early" year, and an "average" year, making for some interesting year-to-year comparisons. Among the many factors measured that relate to nesting ecology were habitat preferences, nest site location, nest phenology, nest density and spacing, clutch size, nesting success, predator influences, fertility, and goose behavior. An especially interesting facet of the study involved the development of a model of body weight dynamics of adult females in spring that calculated the caloric cost of migration, maintenance, egg laying, and incubation and predicted weights and control of clutch size. Energy stores accumulated during spring migration were shown to be essential to flight to nesting range, waiting for nest sites to become snow free, egg formation, and maintenance through incubation. Clutches were largest in an "early" year and in early nests within a year. The mechanism of cessation of egg laying appears to be the exhaustion of accumulated reserves to a "winter" weight level. Winter mortality was clearly the major limiting factor for Mississippi Valley Population geese, and this mortality was overwhelmingly accounted for by hunting.

The report contains 54 tables and 34 figures, all of which are neat and clear. Several black-and-white aerial photographs illustrate the various habitat types in the study area. The text is lucid and very readable. In fact, the only negative aspect of the entire report is its slightly awkward size, being $8 \times 11^{1}/_{2}$"[1] rather than $8^{1}/_{2} \times 11$". Anyone interested in avian nesting ecology and in the importance of well-designed and thorough field studies will find this report to be an excellent source.

NOEL J. CUTRIGHT

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[1]Book Review Editor's Note: 20 cm × 30 cm as result of Ontario Government Metrification program.

Birds in Boreal Canada

By Anthony J. Erskine. 1977. Canadian Wildlife Service, Report Series 41. Supply and Services Canada, Ottawa. 71 pp., illus. $5 in Canada; $6 elsewhere.

This book presents "an overall review of the boreal avifauna, its composition, evolution, and prospects for survival." For eight summers, Erskine made quantitative studies of boreal birds, from New Brunswick to British Columbia, utilizing 40-hectare (16-acre) plots, each of which he visited three or more times.

Merriam's concept of a boreal life zone is seen to be a misleading oversimplification. Erskine shows how bird species composition varies greatly between black spruce, tamarack, balsam fir, and aspen. Further subcategories such as 'shrubs after burns,' 'farms,' and 'balsam poplar of flood-plain forest,' allow even better understanding of bird distribution and abundance.

Although the American Robin and the White-throated Sparrow occupy no less than ten of these habitat niches, the Black-and-White Warbler is listed for only one (poplar-birch forest). The Tennessee Warbler is listed for broad-leaved understory of spruce, for jack pine, for alder understory of tamarack bog forest, for young aspen, and openings (western), but is rare in pure spruce. In stands where balsam fir predominates, one may expect to hear the Winter Wren, Blackburnian and Black-throated Green Warblers, with Bay-breasted Warblers in the more mature stands, and Magnolia Warblers in the younger growth, while the Ruffed Grouse and Blue Jay replace the Spruce Grouse and Gray Jay. One should look for Nashville Warblers in tamarack bog forest.

Inevitably others will disagree with Erskine on some minor points. I would not agree that the Red-

tailed Hawk is more characteristic of conifer than of broad-leaved forests. I would add Sharp-tailed Grouse, Black-billed Magpie, and House Sparrow to the list of birds characteristic of northern farms, the Great Crested Flycatcher, Cedar Waxwing, and Connecticut Warbler to the list for aspen forest, especially in parkland areas, and the Vesper Sparrow to the list for more southerly jack pine forests. I do not agree that Least Sandpipers breed in boreal fens at this latitude.

Erskine contends that birds of the boreal forest have attracted less study than those of any other part of Canada. Nevertheless, his is a personal project that fails to review many published studies from the region; Flack's review of aspen parkland birds is mentioned but some of Flack's important conclusions are ignored.

This is a landmark publication. It heralds a new recognition by the Canadian Wildlife Service of its responsibility for "dickey birds" and their ecology. It contains a wealth of ecologic and distributional data, brilliantly analyzed and synthesized. It demands careful and repeated perusal by everyone interested in boreal birds.

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Lexique anglais-français, Termes techniques à l'Usage des Biologistes

By Jean Vaillancourt. 1978. Editions de l'Université d'Ottawa, Ottawa. 427 pp. Paperback $12.00.

Biologists, like the animals they study, must look beyond linguistic and national boundaries, to be aware of developments in their field. This lexicon, of a high degree of completeness, will help the biologist reap the full benefits of discoveries in two of the world's most important languages.

The lexicon consists of two principal parts. The first and largest is an English-French lexicon with the entries listed alphabetically in English and numbered consecutively. The emphasis is thus on providing the equivalent word in the other language rather than a definition. The second section is an alphabetical index of French terms keyed by number to the first section. This approach permitted condensation of the text and reduction in cost without loss in utility.

The English-French lexicon is laid out in the following manner: the English word in boldface type, which permits the word to be easily picked out, followed by one or more classificatory abbreviations such as Anat., Biol., Zool., Océanogr., Méd., Bot., Ichtyol., Ornith., Micr., etc.; the French synonym or synonyms; the plural form (only when irregular); and the gender.

The only other even roughly comparable sources the reviewer is aware of are the following: *Glossaire de biologie animale* by Roger Husson (1970, Gauthier-Villars, Paris), which is unilingual and gives about 2500 definitions; the *Dictionnaire français-anglais, anglais-français des termes médicaux et biologiques* by Pierre Lépine and Philip R. Peacock (1974, Flammarion, Paris), having some 6500 words; and the *Dictionary of biology* by Günther Haensch and Giselin Haberkamp de Anton (1976, Elsevier Scientific Publishing Company, Amsterdam), with synonyms in four languages for about 9800 terms. (There are also a number of unilingual English biological dictionaries.) None of these give comparable coverage. To check the thoroughness of coverage the first 25 biological terms found in the preceding dictionaries were checked to see whether they were included in Vaillancourt's lexicon. Of the 25 terms in all three, about 90% were found in Vaillancourt. The reviewer has a rather specialized manuscript dictionary of ichthyology. Even in this case about half these specialized terms were found in Vaillancourt. The coverage is clearly very good. Over 10 400 terms are included.

The disciplines covered include bacteriology, botany, zoology, marine biology, anatomy, systematics, evolution, ecology, limnology, oceanography, genetics, paleontology, pharmacology, and physiology as well as related terms in geology and geography.

In a discipline as broad as biology it would be impractical to include every term. Only a few omissions were noted — neotype (néotype), meristic (méristique), and ray in the sense of fin ray (rayon), although ray in the sense of a kind of fish was included. Ichthyologist and fish(eries) biologist are equated, although in general use the first is usually restricted to the theoretical student of systematics, anatomy, evolution, ecology, and zoogeography of fishes, as opposed to the applied management of fishes; however, these are minor points.

I wholeheartedly recommend the addition of this book to your biological library. There have been many times that I wished I had a comparable authoritative source book. Vaillancourt is to be congratulated for his breadth of coverage which will make it invaluable for the student and professional.

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An Introduction to the Aquatic Insects of North America

Edited by R. W. Merritt and K. W. Cummins. 1978. Kendal/Hunt, Dubuque, Iowa. 441 pp., illus. US $18.95.

Nearly twenty years have passed since a new comprehensive reference work on aquatic insects has been published. Although the publication of this book dealing with aquatic entomology will not render any of the existing texts obsolete, it is a long awaited up-to-date synthesis of the taxonomic status of the various groups of aquatic insects. The greatest improvement over existing books of this kind is the shift in emphasis from the traditionally taxonomic theme to one that includes extensive ecological information.

The taxonomic treatment of the insect orders presented in the text has been restricted for the most part to the familial level. Only a few of the smaller orders such as the Megaloptera and the Neuroptera, and a few families of aquatic Diptera, notably the Tipulidae,Culicidae, and Simuliidae, are dealt with at the generic level in the keys. The opinion of the editors was that a single reference work treating all major life stages to the generic level, as well as including the ecological data, would be of prohibitive size. Presumably the inclusion of the extensive ecological information for the orders has been done at the expense of the taxonomic sections to provide a more encompassing review. This decision by the editors is commendable for it has resulted in a wide range of information available in a single text. In view of the frequent changes that occur at the generic and specific levels, the restriction of the taxonomic information to the family level by the editors should also result in a book less subject to the need for major revisions. In addition each section contains a listing of the major references to more detailed taxonomic studies. Thus the lack of generic keys has little impact on the usefulness of the book.

Although the taxonomic sections generally deal with the organisms at the family level, most of the genera are mentioned in the ecological treatment of each order. The ecological data has been compiled into tables and the editors have maintained a consistency throughout the book while including as much ecological information as possible in a readily obtainable form. This is especially significant considering the diversity of contributors involved in the preparation of the text. The reader need only find the genus of interest and read across the page to determine its habitat, behavioral characteristics, trophic relationships, and distribution in North America. As well, references to specific ecological studies are also included if more information is required.

Additional topics pertaining to aquatic entomology serve as introductory to the systematic and ecological sections on the insect orders. The section dealing with sampling methods and equipment deserves special mention. The full range of aquatic habitat types is presented in tabular form with a listing of the sampling methods and equipment considered most suitable for each habitat type. The references to pertinent literature that are contained in this section appear to have been carefully selected to include both proponents and critics of the various methods outlined in the tables. The most commonly used equipment is well illustrated by diagrams, and a list of suppliers, complete with addresses is provided in the text. Canadian readers, however, will be disappointed that this list contains only suppliers in the United States and does not mention Canadian distributors.

The chapter dealing with the general morphology of the aquatic insects is, like the rest of the book, well illustrated by diagrams. Unfortunately, only the stoneflies are illustrated in the immature stage, which in a book geared towards students, provides little guidance for those attempting to work with highly specialized forms such as the larvae of aquatic diptera.

A generalized treatment of phylogenetic relationships and evolutionary adaptations of aquatic insects completes the non-systematic sections of the book.

The book appears to be aimed towards the amateur collector and the beginning student of aquatic entomology, but its use is by no means restricted to this group. Although the generalized treatment of the topics contained in the text clearly demonstrates this bias, the work is also an excellent source book that the professional can draw from. The editors have definitely succeeded in producing a work that will be of use to all levels of interest and expertise in aquatic entomology for many years.

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Nichoirs d'oiseaux

Par Raymond Cayouette, illustrations de Jean-Luc Grondin. 1978. La Société zoologique de Québec, Charlesbourg, Québec. 36 pp. $4.

Cette plaquette brochée de 36 pages a des dimensions qui sortent de l'ordinaire (25,5 x 20,0 cm), mais qui contribuent à mettre en relief la valeur générale de l'ouvrage. La composition et la présentation graphiques sont très agréables et de bon gout. Le papier est de bonne qualité et l'impression est soignée. La reproduction des planches en couleurs compte parmi les meilleures que j'aie eu l'occasion d'examiner au cours des dernières années et rend justice au talent de l'artiste.

L'ouvrage comprend cinq parties principales qui varient en importance.

L'introduction et les généralités occupent les huit premières pages et on trouve en neuvième page une liste des espèces qui utilisent des nichoirs. Les auteurs traitent en détail de vingt espèces d'oiseaux nicheurs dans les vingt pages suivantes, et des modèles de nichoirs accompagnés de dimensions apparaissent à la fin de l'ouvrage.

Ce qui frappe surtout dans cette plaquette c'est la finesse des illustrations, c'est du Jean-Luc Grondin à son meilleur. Grâce à ce travail Grondin s'affirme parmi les meilleurs artistes-naturalistes du pays. Son style est sûr et il maîtrise très bien sa technique. Il concilie à la fois le souci du détail et un grand sens artistique et démontre qu'il est aussi à l'aise avec les illustrations en couleurs qu'avec le dessin au trait qu'il a si heureusement utilisé antérieurement.

Le texte Raymond Cayouette est clair, précis et bien rédigé. On y trouve une quantité de détails intéressants et généralement précis sur la nidification des oiseaux en général et sur les 20 espèces qui sont traitées dans le texte. Ces dernières sont accompagnées d'illustrations. En page 5, l'auteur mentionne que l'Hirondelle pourprée "a diminué de façon évidente la quantité de moustiques" dans une région des États-Unis. Or il s'est avéré, à la suite d'études récentes, que l'Hirondelle pourprée consomme peu de moustiques! On a quelquefois confondu "couvée" avec "ponte." Ponte désigne toujours l'ensemble des oeufs pondus par un oiseau.

J'ai constamment noté que les longueurs des oiseaux diffèrent appréciablement, dans certains cas, des longueurs reconnues pour ces espèces. Les périodes de couvaison données sous le vocable "Durée de l'incubation" ne sont pas toujours en accord avec celles reconnues dans des études de ces espèces. De même le rôle des adultes dans la couvaison, tel qu'indiqué dans le texte, n'est pas toujours conforme aux données fournies ailleurs! Les aires de nidification au Québec sont générales, mais précises sauf dans le cas de l'Etourneau sansonnet que l'on fait nicher à Fort-Chimo!

Les dimensions recommandées des nichoirs apparaissent dans un tableau ingénieux en page 33 et dérogent peu des dimensions recommandées par plusieurs auteurs. Les modèles de nichoirs suggérés en pages 34, 35 et 36 ne sont pas innovateurs, mais suffisent pour qui veut se donner la peine de les construire pour le plus grand bénéfice des oiseaux qui les utiliseront.

En résumé, cette petite brochure, malgré quelques imprécisions de texte, est un excellent achat, même à $4.00, à cause de la beauté des illustrations et des renseignements qu'elle renferme. C'est sans réserve que j'en recommande l'achat à tous ceux qui s'intéressent aux oiseaux et qui veulent leur offrir des sites de nidification supplémentaires.

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Birds in Peril: a guide to the endangered birds of Canada and the United States

By John P. S. Mackenzie. 1977. Pagurian Press, Toronto. 191 pp., illus. Hardback $14.95, paper $7.95.

I have often felt that an author who attempted to write a topical book on an environmental issue did so at considerable risk, for new information is constantly being revealed that dates the author's effort or contradicts his work. Endangered species has especially been the topic of considerable verbiage, much of it ill-informed. Despite these obstacles, John Mackenzie has made a worthwhile effort in bringing to the public's attention the plight of some endangered or threatened birds.

The book relates the history of 20 species or subspecies of birds in North America, how they became threatened, and what steps are being taken to help prevent their extinction. Refreshingly, stories have been included to illustrate that intelligent wildlife research and management can help bring a species back to a reasonable population.

Terry Shortt produced twenty color paintings for the book. They have been delicately reproduced and capture the spirit of his art. Additional line drawings are throughout. As usual, the work of Terry Shortt is superb. Having just visited an exhibit of his work that

included the original color paintings for the book, I recommend the book for Shortt's paintings alone.

The introductory pages are clearly but simply presented with no new insights or information offered. A discussion on the complex factors that usually work together to cause a species to become threatened would have been helpful. For example, should threatened wildlife be managed on a species, sub-species, or population level? Or, should an animal be considered endangered when it is merely occurring on the fringe of its range? The initial discussion was inadequate.

Each discussion is broken into sub-headings: history, decline, life cycle, aspects of biology and behavior, what is being done and the future. This is a good feature, for it provides a wide range of information that can easily be found for each species. Much more could have been added and the reader should not view the text as definitive accounts.

Occasionally the writing is unclear. On page 12, for example, the comment, "commercial interests such as mining, oil, gas . . . support environmental studies" "financed a multitude of environmental studies on all aspects." True, corporations have undertaken many studies but we cannot lightly dismiss corporate responsibility for on page 22, the author mentions the hazards of oil tanker traffic, which will be greatly increased when the pipeline is complete. As far as I am concerned, the jury is still out on both government and corporate responsibility towards the environment. Wildlife is just not perceived by decision-makers as a competing resource.

The inclusion of success stories in the management of endangered species is a welcome addition. Discussions on the Trumpeter Swan, Hudson Godwit and others is helpful. I found too much emphasis placed on the work being done by the United States Fish and Wildlife Service, although this may reflect the most ambitious program. I had the feeling at times that the "what is being done" section was overkilled and tended to be repetitive.

One can quarrel about many "nits" especially by a reviewer who works in the wildlife management field, but on balance, the book is well put together and provides a good source of information for the layreader.

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BOTANY

Manual of the Vascular Plants of Wyoming

By Robert D. Dorn. 1977. Garland Publishing Inc., New York and London. 1498 pp. (2 volumes). US $95.00.

These two volumes, if they had been typeset rather than typewritten double-spaced, and often with large blank spaces on the pages, could have been condensed into one easily handled volume.

The author has deliberately not included infraspecific taxa, some annual grainfield weeds, species growing only under irrigation conditions such as lawn weeds, and species to be expected but not yet found in the state. One cannot argue about a decision to produce a conservative treatment, and as well not to include extraneous taxa. It does seem unfortunate, however, that a large part of the introduced flora has been ignored. This is particularly so, because students who will test the keys will probably do so on plants gathered from about townsites and college campuses, and thus be frustrated because the correct answers are not always forthcoming.

The order of the flora is strictly alphabetical within the three large groupings of Pteridophytes, Gymnosperms, and Angiosperms. Descriptions are relatively short; habitat information is adequate; distributions are given only for the state of Wyoming and sometimes only by the name of a county; synonomy is minimal; the few line drawings scattered throughout are by Jane L. Dorn.

An appendix near the end of the second volume includes a page on geography and climate, a map of the state depicting counties, sections on historical vegetation, present vegetation, natural vegetation types, selected references, rare and endangered species, early collectors in Wyoming, and a summary giving a breakdown by family of the 605 genera and 2144 species treated. This might perhaps better have been placed with the introductory material in the first volume.

The high cost, coupled with the bulkiness of this work, will undoubtedly mean that few students, for whom it was written, will put it on their bookshelves.

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A Provisional Checklist of Species for Flora North America (Revised)

Edited by S. G. Shetler and L. E. Skog. 1978. Missouri Botanical Garden Monographs in Systematic Botany Volume 1: 1–199. Paper US $6.50.

This revised checklist which includes 16 274 species, 2350 genera and 233 families is a tangible result of the efforts of many individuals, and particularly of Shetler, towards what was eventually to have produced a Flora of North America. It is indeed a step towards such a flora, and is a document from which a general review and revision of the flora can begin.

The area covered is that part of North America north of the Mexican border, including Greenland. Included are names of taxa, authorities, coded information of four categories of plant characteristics, range given by 16 regions, and the source of the information. There is no synonymy. The computer printout has been photoreduced in order to incorporate more information on each page, and this has made legibility somewhat more difficult.

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Garden Spice and Wild Pot-herbs. An American Herbal

By W. C. Muenscher and M. A. Rice. 1978. Cornell University Press, Ithaca, New York. 213 pp., illus. US $16.95.

This book contains accounts, botanical, culinary, and horticultural, of approximately 70 plants, primarily cultivated plants, used as herbs and spices. An illustration of each plant is provided, showing the stage at which the particular plant should be harvested. The illustrations themselves have been prepared from the original wood-cuts by Elfriede Abbe. Included in the botanical aspects of the book are short accounts of the plant families represented as well as brief descriptions of each of the species included. Scientific names are given, with some frequently used synonyms being listed in the appendix, as well as common English, French, and Italian names. The culinary notes are rather general but include information on the usual uses of various portions of the plants. I suspect that cooking has a "common-name problem" similar to that which led to the establishment of scientific nomenclature: horseradish sauce is described as "an alcoholic infusion" to my great surprise. I can only suspect that Muenscher and I know different sauces by the same name.

Medicinal and nutritional notes are also included, the former I suspect being primarily of the folk-medicine genre. It is unfortunate that the glossary is restricted to botanical terms, for many of those used in the medicinal portion are probably unfamiliar to the majority of readers. What does a carminative drink do?

For those with gardens, but particularly those with gardens in southern Canada, the horticultural information will be of interest. In this regard, the hardiness table, showing survival rates at Ithaca, New York, for the winter of 1942–43, offers more concrete information than is usually available.

My own reaction to the type-face used, Goudy Kennedy Bold and Italic, was negative: it seemed hard on the eyes. On the other hand I think it did help to induce a relaxed, browsing mood and this is, I would say, a book for browsers rather than readers. It contains a lot of fascinating information and I anticipate dipping into it fairly frequently both when I am planning a meal and when asked a question by a home gardener interested in growing herbs and spices. It is a reprint of the original 1955 edition.

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How to Identify Grasses and Grasslike Plants (Sedges and Rushes)

By H. D. Harrington. 1977. Swallow Press Inc., Chicago, Illinois. 142 pp., illus. US $3.95.

Grasses, sedges, and rushes are often not even considered "proper" flowering plants by amateurs and some beginning botanists. This erroneous impression is reinforced by non-technical identification manuals which totally ignore the three families. The absence of an attractive corolla can apparently only be accepted in trees, which, of course, do not have *flowers* as in "How to identify the flowers of ABC."

Undoubtedly, learning to identify and eventually to recognize the grasses, sedges, and rushes is not

straightforward. The structures involved are somewhat different and generally rather small. Nevertheless so much of our vascular plant flora belongs to these three groups that the botanist, whether amateur or professional, who ignores them or lumps them into a few genera ignores a substantial proportion of the plants in the area.

Harrington's book is not an identification manual. It is, however, an illustrated dictionary and advice manual that anyone tackling the three families for the first time will find an invaluable reference. Terms are not only explained in words but are also illustrated with line drawings. Moreover beginners will be particularly pleased to find that words such as 'anther' are illustrated as well as 'aphyllopodic.'

Most of the book is concerned with grasses (six chapters) with one chapter each for sedges and rushes. In addition, there is a chapter on collecting and pressing and another listing identification manuals that were available at the time of writing. Harrington is consistently encouraging, straightforward, and realistic. He states quite clearly that identification of the three families is not easy but not impossible for the non-professional taxonomist. In reading the book it is quite evident that he has helped numerous students in the past. He will continue to do so.

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Flora of Alberta — a checklist

By D. F. Brunton. 1977. Alberta Department of Recreation, Parks and Wildlife, Edmonton. 43 pp. Free.

This small booklet represents a checklist of the vascular plants of Alberta that has been compiled by the author from E.H. Moss's (1959) *Flora of Alberta*, J. C. Packer and M. G. Dumais' (1972) "Additions to the Flora of Alberta" (Canadian Field-Naturalist 86: 269–274), and J. C. Packer's (1974) *A Supplement to E. H. Moss's Flora of Alberta*. The listed species' names and very abbreviated annotations concerning their generalized distributions in Alberta (e.g., SW & N) or rarity status (e.g., R) have been abstracted entirely from these earlier sources. Thus, this booklet does not represent either a nomenclatorial updating or a reconsideration of the taxa composing the Alberta flora. For most purposes, readers would seem better advised to use the original sources, plus B. Boivin's (1968–72) *Flora of the Prairie Provinces*. For more updated information on the status of Alberta's rare plants, readers should see G. W. Argus and D. J. White's (1977) "The Rare Vascular Plants of Alberta" (Syllogeus, Number 17).

Despite their obvious limitations, I believe such provincial, state or regional checklists of the flora may serve useful purposes. Although not true in this case, checklists often provide the only coverage of the total known flora of a region and represent an important preliminary stage towards the ultimate production of a floral manual with keys and descriptions. A checklist provides a brief, easily consulted outline of the flora and can be conveniently used to check off the plants encountered in more local species' inventories. Space for just such a purpose has been provided in the present booklet. It may prove to be most useful for environmental consultants who are involved with baseline inventory studies of particular areas for impact assessments preceding planned developments. Personally, I find such a checklist to be a convenient source for quickly checking the spellings and authorships of species' scientific names. I believe that the practicality of the present checklist of the flora of Alberta could have been improved by the inclusion of at least the more important synonyms, especially those needed to correlate the species' names used in the floral manuals of Moss, Boivin, and others.

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Freshwater Wetlands: ecological processes and management potential

Edited by Ralph E. Good, Dennis F. Wigham, Robert L. Simpson, and Crawford G. Jackson, Jr. 1978. Academic Press, New York. 378 pp., illus.

This book developed from a conference entitled "Freshwater Marshes: Present Status, Future Needs." The objective of both the book and the conference was to consider all ecological aspects of wetland ecosystems in addition to the production ecology of marshes. This objective, of course, entailed an expansion of the object of study from marshes to the

total spectrum of "wetlands." Wetlands are generally accepted to be the broadest classification category comprising all lands inundated by standing water for a sufficient portion of growing seasons to establish a hydrophytic vegetation, or lands with a high water table and an accumulation (generally accepted to be greater than 30 cm) of raw organic matter which essentially provides the rooting medium for vegetation.

This development from conference to book elucidates the genesis of the book's title *Freshwater Wetlands* but it in no way facilitates this reviewer's acceptance of the term. In the study of marshes, freshwater and saline marshes are convenient and practical subdivisions of the field of study. In the study of wetlands, however, the acceptance of a category of freshwater wetlands involves a flagrant discrimination against a small group of saline wetlands. If generally adopted, this concept could inhibit the investigation of the practical criteria which may be used to distinguish the freshwater and saline subdivisions since workers would be reluctant to approach the 'no man's land' between these two, assumed, compartments.

An erroneous conclusion has been drawn from the developmental sequence which proceeded from a study of marshes to a study of the total wetlands spectrum. This conclusion is — given the direction of this sequence — marsh must be the 'whole' into which all the pieces are to be fitted. Hence we find such anomalies as "bog marshes" (which are fens!), "marsh exploitation by peat mining," "meadow" (blanket bog).

An analysis of the chapters of this book which deal specifically with wetland ecosystems indicates that there has been only a modest attainment of the goal of expanding the scope of the field of study. About 75% of the content of these chapters is devoted to a consideration of marshes, 15% considers open fens, 5% considers a combination of open fens and meadows, and 5% considers the overall category of wetlands. Hence, the consideration of marshes preponderates, and swamps, open and treed bogs, and treed fens, all substantial portions of the wetlands spectrum, have not been treated in this volume.

Because primary production processes form the first section of this book it may be assumed that the editors assign first priority to this aspect of wetland ecosystems. On lands which provide essential agricultural and forest crops, emphasis on production is warranted and the tedious, time-intensive activity of quantitative production evaluations is a worthy endeavor. On wetlands, however, the emphasis on production processes is not justified. If the case for the conservation of wetlands is to be convincingly presented to legislators and to the public, conservationists and scientists should give highest priority to understanding the role of wetlands in serving as groundwater recharge areas, as stream-flow regulators (roles which, at best, achieve no more than brief references in this book), in serving as wildlife habitats and as an important component of an aesthetically-pleasing, varied landscape. Accepting this book's emphasis on marshes, I must observe I have not experienced any competition in my annual harvests of *Typha latifolia* pollen and a significant harvest of marsh emergents for cattle fodder is unlikely since it would seriously conflict with other marsh uses and because, as indicated in this book, the bulk of the mineral nutrients of marshes are contained in the substrata.

I shall temper my predominately negative remarks with a few concluding, positive observations. The Summary and Recommendations sections, which conclude each of the four parts of the book, provide good summary statements on the stage of development of the art and the high priority projects for future work on the four ecosystem aspects — primary production processes, development processes, nutrient dynamics, and management potential.

The contribution of Richardson et al. ("Nutrient Dynamics of Northern Wetland Ecosystems") utilizes a rational wetlands classification scheme so that some of the important nutrient and environmental criteria which characterize the different wetland types begin to emerge.

The contribution of Sloey et al. ("Management of Wetlands for Nutrient Assimilation") is an excellent dissertation on a topic which is likely soon to be an environmental concern. His cautionary statement is worth quoting for *The Canadian Field-Naturalist* readers: "In the past we caused deterioration of the quality of our surface waters by using them to treat our wastes. Lest we make the same mistakes in handling our valuable and diminishing wetlands, it is mandatory that we carry out long-term, carefully-monitored experiments at a severely-limited number of sites. It is important that those conducting these experiments document changes in the natural system that could signal future problems."

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ENVIRONMENT

Boreal Ecology

By William O. Pruitt. 1978. Studies in Biology No. 91. Arnold (Canadian distributor MacMillan, Toronto). 73 pp., illus. Paper $4.80; cloth $10.20.

Boreal ecology is a book of definition and hence one of introduction. Like most other books in this series it is designed to keep teachers and students alike informed of recent developments in biology. It is a book about snow, and to this end Pruitt maintains that the . . . "ecological effects of snow cover are so multi-faceted and all prevading that one might accurately state that boreal ecology is the study of the ecology of snow."

The book deals in generalities and briefly covers the following aspects of boreal ecology: radiant energy and light; water, soil and permafrost; bioclimate; characteristics of boreal vegetation; boreal animals, complete with a discussion of some of their adaptations to the boreal environment, ecosystems, and food webs; human utilization of boreal regions; research methods and procedures peculiar to boreal regions.

Behind Pruitt's exacting and scientific description of the boreal forest regions, there is a message. In essence, it centers upon his belief that continued misuse of this fragile environment means inevitable degradation and eventual destruction. Disruption of the faunal contingent of the boreal forest is well illustrated in the case of the Alaska Tundra Vole (*Microtus oeconomus*). Populations of this vole have extended their range from normal riverine locations into the crevices formed from tractor trains, which through repeated use have exposed the permafrost and subjected it to severe melting. Says Pruitt, " . . . one can only speculate on the possible genetic results of having a population attenuated to one or two *Microtus* wide and perhaps thousands of *Microtus* long." It seems to me that we should begin to stop, look, and listen before unknowingly stepping into trouble.

The text is well organized, easy to follow and supported with maps, diagrams, labelled photographs and tables. The reference list is extensive enough to serve as the beginning point of a literature search.

It is an excellent piece of work and I recommend it to interested beginners and professionals.

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The Environmental Impact of Outdoor Recreation

By G. Wall and C. Wright. 1977. Department of Geography Publication Series No. 11, University of Waterloo, Waterloo. x + 69 pp., illus. Paper $5.

This book evolved out of " . . . a need to synthesize the research on environmental impact of recreation, to draw planning and management implications from the research, and to identify areas of further research."

The text is organized into nine sections: the introduction, which outlines the problem, the study, and the methodology in environmental impact research; geology; soil; vegetation; water quality; wildlife; air; implications and conclusions, complete with planning and site management recommendations; and references.

The impact of outdoor recreation on geology and air, determined by the authors not to be a major problem, is given little space in the analysis. Soil is considered at length; however, most of the literature comes from the United States and England, and consequently, in the Canadian context much of the research has little meaning. Compaction, organic matter, soil nutrients, temperature, run-off and drainage changes, erosion, and soil organisms are considered. The authors suggest that more research is required on temperature, soil organisms, bacteria, and nutrients.

Vegetation, which is usually first to be affected by physical disturbance, is reportedly well covered in the literature. It is reviewed in terms of change in percentage cover and species diversity, plant growth and age structure, and habitat diversity and mechanical damage. The authors believe that more work is required because the research to date has " . . . yielded conflicting results, especially in terms of compaction, soil moisture, nutrient levels and soil organisms, and their associated affects on vegetation species and growth rates."

A considerable amount of research into water quality has been conducted in Canada, especially in Ontario. This work has been completed primarily out of concern for the detrimental effects that cottaging, camping, boating, fishing and other related activities

might have on the aquatic ecosystems. Wall and Wright concentrate their discussion on pathogens, nutrients and plant growth, dissolved oxygen, and pollutants. They suggest that research must continue because " . . . there is a lack of quantitative analyses of change in water quality brought about by different types and intensities of recreational use."

The wildlife section consists of a discussion on disturbance, loss and gain of habitats, alteration of population, and changes in species composition. In my opinion the authors have unsuccessfully attempted to summarize the impact of recreation on wildlife in flowchart fashion. They list the immediate results of intrusion into a wildlife habitat as killing, disturbance and alteration, which results in adaptation, or migration, and a change in reproduction levels. The final result is a change in the population and a different species composition.

It goes without saying that upon intrusion into a wildlife habitat the first three events occur; however, I believe that the primary effect of an intrusion is an alteration of habitat, which in turn causes disturbance resulting in productivity alteration, mortality, emigration or immigration, or adaptation. A change in the population and the species composition then occurs.

The book is reasonably well organized and comes complete with graphs, flowcharts, and a reference list. The composition is weak in a few areas and the authors have a tendency toward wordiness; for example, "Even without the intervention of man, the environment would not be unchanging, but would be in a perpetual state of flux." They might have said, 'Even without the intervention of man, the environment is naturally dynamic.'

I recommend this book to those unfamiliar with this subject and interested in developing a basic understanding of environmental impact.

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L'inventaire du Capital Nature: méthode de classification et de cartographie écologique du territoire (3éme approximation)

By M. Jurdant, J. L. Bélair, V. Gerardin, and J. P. Ducruc. 1977. Péches et Environnement Canada, Québec. Approvisionnements et services Canada, Ottawa. 202 pp., illus. $7.00, $8.40 (other countries) French.

The purpose of this volume, aimed at those individuals involved in land management, is to introduce a method for land classification and ecological survey. It has taken ten years of field verification and re-evaluation to perfect this method and present it in a workable document. Initially the development of the method was started in 1967 as a pilot project in the Saguenay/Lac-St.-Jean region of Quebec; its workability was verified when Jurdant's team undertook the ecological survey of 350 000 km^2 in the James Bay area.

Chapter 1 outlines the goal and objectives of the ecological inventory. The goal is to produce cartographic documents that are characterized by the most permanent bio-physical parameters of the environment and hence provide an ecological basis for planning the integrated management of the resources of a given territory. They achieve this goal by producing an ecological map that summarizes the biophysical parameters investigated.

In Chapters 2 and 3, the authors discuss the basic concepts and criteria used in ecological classification. The basic taxonomic unit for the inventory is the ecological phase which is defined by the combination of certain vegetation and soil characteristics (this uses the concept that vegetation and soil are the best integrators of variation in biosystems and geosystems respectively). For the method to work the classification criteria must indicate the intrinsic properties and the actual state of the ecosystem. The criteria must be measurable and should contribute in some way to vegetation evolution. Twenty-one criteria are listed for both terrestrial and aquatic ecosystems.

Chapters 4 to 9 describe in very precise terms the levels of ecological detail that are observable at different cartographic scales, the methods of classification and cartography, and the methods for analyzing vegetation. An example of what and how to measure, how to record data at all ecological reference sites, and how the cartography is interpreted and applied for management purposes is given. The maps and annexes demonstrate the workability of the ecological survey method.

As I have indicated to many of my colleagues, this book will be an invaluable asset to ecologists, planners, and managers at all levels of government, and to private industries and especially to those involved with the preparation of environmental impact statements.

The book is replete with original drawings and caricatures by L. Renaud, that add to the readability of the prose. In addition, the authors have included several flow charts depicting the basic concepts of the ecological survey and outline how a multidisciplinary team should be organized to carry out a successful ecological inventory.

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Applications de la Télédétection à l'Étude de la Biosphère

By C. M. and M. C. Girard. 1975. Masson, Paris. 186 pp., illus. Paper in French. 96F.

Remote sensing techniques (both instrumentation and application) have developed very rapidly since 1970. This text, published in 1975, is very scientific in its approach, is extremely well documented, is clear and to the point, is logically structured, and is very particular to details in methodology and definition. The work examines a wide spectrum of applications and the in-depth analysis of examples will certainly be appreciated by the readers. The Girards have organized this work into four parts, each complete in itself.

In part one, 'Remote Sensing,' the authors present a discussion of the principles involved. They describe the characteristics and the energy sources of the electromagnetic spectrum, the influences of the atmosphere, and explain the mechanisms involved for the peculiar behavior of vegetation, soil, water, ice and snow in different spectral ranges such as the visible and near infrared, middle and far infrared, and the very high frequencies. Both photo and non-photographic instrumentation is described. Data treatment analysis, i.e., visualization, increasing contrast, and information selection, as well as factors that influence the utilization of data are given.

Part Two is entitled 'Methods' with the emphasis being placed on methods of photo and image interpretation.

Sixty percent of the book (Part Three) is devoted to 'Interpretation.' It is a detailed account applied to vegetation, pedology, agronomy, and to anthropogenic influences. Text examples are often related to actual photographs. The interpretation of vegetation is looked at from the point of view of species identification, recognition of vegetation assemblages, edaphic conditions, and succession of plant communities. The pedology section looks at the identification of soil characters that are both readily and not readily discernable. Examples are also given. The interpretation of agricultural lands is also treated. The authors give information on crop identification, soil modification, and touch on the problem of agronomic cartography. They also expand on the utilization of remote sensing for pest control. Anthropogenic influences on the environment are increasing. The artificial interferences by man that lead to urbanization are not treated. What the authors do look at is the interpretation of influences on the natural environment and rural modifications.

In Part Four an example of how high-altitude data (35 km high from balloons) are utilized in interpretation and thematic cartography (i.e., geology, soil utilization) is given. This part concludes with a flow chart on data treatment by computers.

During the three years since publication, many innovations have occurred in the field of remote sensing. This text remains a valuable source of material for those interested in acquiring a basic applications reference. It is recommended for use at the university level and by current practitioners.

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Wildness Is All Around Us: notes of an urban naturalist

By Eugene Kinkead. 1978. Dutton, (Canadian distributor Clarke Irwin, Toronto). 178 pp., illus. $12.50.

Wildness Is All Around Us is an informative and entertaining book that offers a variety of insights into some items of natural history, plus many entrancing digressions. For example, the essay on the coyote (pronounced *ky oat*) describes not only its distribution, paleontological and recent history, appearance, behavior, relationship with man, and reproduction with other canids, but also includes lengthy asides on endangered species (of which the coyote is certainly not one), on sheep and sheep-ranching, on

wolves, and on the principles of heredity. But there is almost nothing about coyotes in cities, despite the subtitle of the book.

Kinkead also includes a long essay on the House Sparrow, a fascinating history of this species' introduction to North America (Manhattan) in and after 1848 to reduce the measuring-worm population, (even though anti-sparrow organizations existed in England as early as 1744), and its subsequent conquest by 1880 of much of the continent. Until that time these widely-acclaimed birds were shipped freely about the country to eradicate noxious insect pests. After that time, however, the sparrow was seen rather as "an evil of monstrous proportions." Sparrows molested over 70 species of native birds; ate fruits, vegetables, grain crops, and urban plantings; and around dwellings were dirty, noisy, and blatantly promiscuous. The *New York Times* predicted in 1887 that once Americans realized how tasty sparrows roasted with bacon were, their numbers would be decimated by cooks, but this did not happen. Instead sparrow populations continued to expand until about 1910, when the increase in the automobile and consequent decrease of horses and the grain they ate undercut the sparrows' food supply, especially in winter and in cities. Since then sparrow populations, although still numerous, have stayed within more reasonable bounds.

The other chapters in this book are really vignettes rather than essays. The first describes the pandemonium which took place one spring when a Steller's Eider from Siberia was spotted off the Boston South Shore. The area was soon swamped with birders wanting to increase their Life List, alerted by a message taped for the "Voice of Audubon" Boston telephone number. The second is about a rare birch tree, *Betula uber,* rediscovered with the help of the author after 60 years beside a creek in the Appalachians of Virginia. The geological history and the wildflowers of Central Park in New York City are the subjects of the other two chapters.

Although Eugene Kinkead is primarily a writer rather than a biologist, he includes in this book a wealth of biological information. He is not correct, however, in saying that no person in North America has been attacked by a healthy wolf. In northern Ontario in 1942 a wolf knocked a railman off his handcar, and, while canoeing in 1893 through the barren lands of Canada, J.B. Tyrrell's party was beseiged by wolves. Similar attacks have occurred in Eurasia. I think also few would agree with the dust-cover statement that the fox is threatened with extinction.

This well-written book with its few, evocative sketches uses a format which could profitably be a model for many would-be authors writing about nature. I recommend it highly to both laypeople and professional biologists.

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OTHER

Field Photography: beginning and advanced techniques

By Alfred A. Blaker. 1976. Freeman, San Francisco. (Canadian distributor Oxford University Press, Toronto). 450 pp., 55 black and white plates, 12 color plates, plus 41 pp. field book. $19.95.

This book is a very comprehensive treatise on the subject of field photography. It follows the same format and style as the author's previous publication, *Photography for Scientific Publication: a handbook* (Freeman, San Francisco, 1965), which presented a synthesis of laboratory photographic technique. The purpose of this publication is instructional; the author states in the preface that, "this book will represent a self-teaching aid to help interested persons improve the quality of photographs they may need." The text accomplishes this purpose.

The book is organized into three sections: Background, Basic Photography, and Field Photography Techniques. There are also three appendices containing film speed data as well as development and copying information. A supplemental pamphlet summarizes mathematical tables and formulae in a form suitable for field use.

The background section introduces the reader to scientific field photography. It discusses merits of photography, photographic training, and offers advice on photographic operations. This information is valuable to persons currently involved in professional photographic capacities. The author continues this section with a discussion on the tools of photography. He accurately and extensively describes cameras, film,

development materials, and essential accessories used in modern photography. This discussion has two minor, unavoidable problems: personal bias and some outdated information.

The second part of the text, basic photography, is most informative to the incipient nature photographer. An initial short chapter describes considerations related to composition of photographs, or as the author puts it, "seeing a picture." This section is very informative, and is highly recommended for both inexperienced and veteran photographers.

Blaker next presents explanations concerning basic topics of photography such as exposure, photographic filters, and darkroom procedures. The data given here are detailed and it is recommended that the reader be concerned only with problems of his/her particular interest. Although the writing style here is clear enough, there is some difficulty in grasping the extensive reference material in one quick reading. If a simplistic discussion of these fundamental topics is required one should seek elsewhere.

The final portion of the text deals specifically with field techniques. Blaker commences this section with an appeal to field workers to maintain ethical ecological considerations while endeavoring to capture a picture. This is sound advice that all nature photographers should attend. A short section on climatic problems in photography and proper equipment preparation for field work, rounds out this interesting division of text.

The remaining chapters of this section contain information on essential topics of nature photography: close-up, long-range (telephoto), and wide-angle photography. The author begins with close-up (macro) imaging. He explains equipment, background theory (of focal length changes, etc.) and comments on special problem areas. This information is very useful, especially the data on close-up photography with flash equipment.

The chapter on telephoto work is unfortunately not as helpful. Some advice here is questionable; for example, the point is made that teleconverters give as good (or better) results for a portion of the cost of telephoto lenses. A pertinent point overlooked is that the image one obtains is directly related to the quality of the lens with which it is captured. Blaker does not explain that teleconverters of sufficient optical quality are not inexpensive. A telephoto lens with its added versatility may on occasion be a better choice of equipment.

The next chapter gives a brief description of wide-angle photography. Although little emphasis is placed on landscape photography, the remainder of the chapter is complete.

The last two chapters deal with stereo photography, which is not an essential element in most field work. But this section presents interesting information that may invoke novel methodology in future field photography.

Field Photography is a book that offers something for every nature photographer. The more experienced will want this text for use of its inexhaustive reference data and extensive bibliography. Beginners will find the material on basic photographic procedures very worthwhile, and advice on problem areas invaluable. All will appreciate its wide scope, logical presentation, and picture quality. A word of caution: this publication is designed as a reference text and is written accordingly.

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NEW TITLES

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A birdwatcher's adventures in tropical America. 1977. By A. F. Skutch. University of Texas Press, Austin. xiii + 327 pp., illus. US$13.95.

*A bird watcher's guide to the eastern United States. 1978. By Alice M. Geffen. Barron's Education Series (Canadian distributor Burns and MacEachern, Toronto). 384 pp., illus. US$15.95.

†Ducks, geese and swans of the world. 1978. By Paul A. Johnsgard. University of Nebraska Press, Lincoln. xxiii + 404 pp., illus. US$35.

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†Available for review
*Assigned for review

Minutes of the Ninety-Ninth Annual Business Meeting of The Ottawa Field-Naturalists' Club

The 99th Annual Business Meeting of The Ottawa Field-Naturalists' Club was held in the auditorium of the National Museum of Natural Sciences, on 10 January 1978. The President, R. A. Foxall, called the meeting to order at 8:17 p.m., with a quorum of 26 persons present (final total, 27). The Recording Secretary read the minutes of the 98th Annual Meeting, which were approved on motion (by K. Strang, 2nd, H. Thomson).

R. Foxall referred to business arising from the minutes. The Council had directed the Publications Committee to consider the status of *The Shrike* as a Club publication; the Committee has recommended that *The Shrike* be considered a publication of The Ottawa Field-Naturalists' Club, a recommendation accepted by the Council. As recommended at the last Annual Meeting, the Conservation Committee had considered the matter of the necessity for approval by Council of all reports and briefs; and had recommended that all significant submissions, containing policy statements or contentious issues, should be cleared by the President or his designate. A General Meeting of the Club, on Centennial planning, had been held in June 1977, to inform the membership of the projects being undertaken, and to get ideas of the interests of the members.

In the absence of the Treasurer, the Club's accountant, M. Brigham, was called upon to present the 1977 financial report. Unfortunately, this had not been audited, owing in part to the current prevalence of the 'flu'. R. Taylor, the Chairman of the Finance Committee, explained that the change of the financial year, to end at the end of September, was to relieve the pressure on the Treasurer's Assistant and the Auditors to produce the statement in time for the Annual Business Meeting; closing the books in December had always been difficult, particularly with membership dues still coming in at that time. For this reason, this year's statement covers only nine months. Taylor also explained that the apparent large profit to the Club was due to the lack of allocation of funds to *The Canadian Field-Naturalist*. Excluding 'windfall' items such as life memberships, which cannot be budgeted, the Club had actually operated at a slight loss, justifying the increase in membership dues for 1978. *The Canadian Field-Naturalist* profit was due mainly to the success of the raptor issue; the grant request to the National Research Council for 1978 has been reduced accordingly.

R. Foxall raised the point that the Auditors, approved at the last Annual Meeting, were G. J. Wasteneys and D. Potter; since that time, D. Potter has changed his job and will not have time to do the audit before the end of February. Wasteneys is still available, but the Constitution requires two auditors. C. Gruchy moved (2nd, E. Dickson) that the responsibility for finding a second auditor for the financial year ending September 30, 1977 be delegated by the Annual Business Meeting to the President of The Ottawa Field-Naturalists' Club; this was approved unanimously. Gruchy then questioned the need for the Club to have two auditors; M. Brigham agreed that one person could do the job. It was recommended that this matter should be examined by the Council to see whether a change to the Constitution may be in order.

R. Taylor moved (2nd, C. Gruchy) adoption of the interim, unaudited, financial statement covering 1 January 1977 to 30 September 1977; the motion was approved.

The Annual Report of Council, to be published in *The Canadian Field-Naturalist*, was read by R. Foxall. A. Erskine pointed out that there were deficiencies in, rather than lack of, knowledge of our area's natural history; and Todd suggested that the Pink Road feeder should in some way be identified as the Lucerne feeder mentioned in the previous report. Acceptance of the report, as amended, was moved by S. Hamill, 2nd, C. Gilliatt, and approved.

M. Brigham moved a vote of thanks (2nd, J. Harrison) to all the volunteers who look after the Club's bird feeders: George McGee and Bill Holland, Mr. and Mrs. Hugh Munro and W. Earl Godfrey, Jean Hastie, and John Dubois. Motion approved unanimously.

Foxall then called on C. Gruchy, as Chairman of the Nominating Committee, to present the slate. Gruchy apologized for not having published a request for nominations, but said that despite this, one nomination had been received from the membership at large. He then presented the slate:
President: R. A. Foxall; Vice-President: R. Taylor; Treasurer: B. Henson; Recording Secretary: D. Laubitz; Corresponding Secretary: S. Armstrong; additional members of Council: E. Beaubien, C. Beddoe, W. Cody, J. Diceman, E. Dickson, A. Dugal, C. Gilliatt, C. Gruchy, P. Hall, J. Harrison, V. Hume, H. MacKenzie, J. Murray, M. Ney, G. Patenaude, K. Strang, S. Teeple, E. Todd.

On motion (by C. Gruchy, 2nd, M. Ney) all of those nominated were declared elected. R. Foxall, on behalf of the Club, gave thanks to those Council members who were retiring: Tony Erskine, Gavin Nicholson, Gerry Oyen, Pamela Sims, and Stan van Zyll de Jong.

The Auditors for 1977–1978, G. J. Wasteneys and M. Brigham, were approved on motion (by R. Taylor, 2nd, E. Todd).

Foxall then reported that plans for some of the Centennial projects are proceeding well, but that despite many appeals there have been very few volunteers, and some of the planned activities may have to be dropped. It is felt that the Club deserves a good Centennial celebration, but perhaps our ideas have been too ambitious. We will also need many volunteers to do small jobs during 1978. E. Dickson asked whether the list of people who have offered their skills to help the Club had been consulted by the Centennial Planning Committee; D. Laubitz answered that it had been consulted when specific skills had been needed. M. Brigham raised the point that some of the proposed Centennial projects concern saleable items; that the cost of these items may be about equal to the amount for which they can be sold; and queried whether consideration had been given to the need for advertising to promote sales. R. Foxall replied that the costing of items for sale is indeed a difficult task; and that advertising was being considered an important adjunct to selling Centennial items. He emphasized that 1978 will be a very busy year for the Council and the Club.

J. Harrison moved (2nd, A. Hanes and E. Dickson) a motion of thanks to Harry Thomson for his long and dedicated service to the Club, as Business Manager of *Trail & Landscape,* from which position he is now retiring after 11 years. The motion was warmly approved by all present.

E. Todd thanked the President, on behalf of the Club, for carrying on the business of the Club during 1977, a job which Todd knew by experience to be a frequently thankless one.

Adjournment of the meeting (on motion by B. Henson, 2nd, K. Strang) was at 9:35 p.m.

Following the refreshments, color slides were shown by J. Harrison, M. Ney, and D. Black.

D. R. LAUBITZ, Recording Secretary

Report of Council of The Ottawa Field-Naturalists' Club

The consideration and support of Centennial projects has taken up a large proportion of Council's time during 1978. One result of the Centennial program is that we have been reminded that our members may have in their possession valuable archival materials referring to The Ottawa Field-Naturalists' Club. Club members are therefore reminded that any relevant materials for which they no longer have any use will be gladly received by the Public Archives.

For the **Centennial Steering Committee,** 1978 was a period of major activity, leading to Council approval of 14 of the 33 Centennial projects that had been proposed. The Club pin, designed by W. Rath, will go on sale at the Centennial Banquet, to be held on May 19. An exhibition, '100 years of looking at nature,' will open on May 18 as the preliminary to a weekend of seminars, workshops, and field trips on natural history topics. In September, we shall combine a day of field trips with a Club picnic. Hasty-notes, designed by E. Dickson, and the Centennial Calendar, featuring works by Club artists, have already been produced; being prepared for publication are a reissue of John Macoun's Autobiography; 'Orchids in the Ottawa District' by A. and J. Reddoch; Cumulative Indices to *Transactions of The Ottawa Field-Naturalists' Club* and *The Ottawa Naturalist* compiled by J. Gillett; and a revised 'Checklist of Birds of the Ottawa Area' by B. Barrett. A stereo recording of 'Nature Sounds in the Ottawa Area' by F. M. Brigham is close to completion. Two projects still in the early stages of preparation are 'Birds in the Ottawa Area 1979,' a record of bird sightings and abundance in Centennial year to be published in 1980; and the Macoun Club's natural history 'Trail and Guide,' which was held up owing to a forced change of location.

(Hue MacKenzie)

The **Centennial Ways & Means Committee** was set up to assess Centennial projects' costs; to determine the availability of The Ottawa Field-Naturalists' Club funds to meet these costs; and to recommend ways of raising additional funds should they be required. Total project costs are now estimated to be approximately $40,500, with recovery through sales of about $18,400, giving an estimated net outlay of $22,100. Moneys available through Club funds are about $50,000; no action to obtain additional funds from outside the Club was considered necessary.

(C. Gilliatt)

Finance Committee: The 1977–1978 budget was adopted by Council early in the year. With the financial year ending in September, the books were presented to the auditors on time, and the 1978–1979 budget was presented to and approved by Council at its December meeting. Ivy Hewis resigned as Assistant

to the Treasurer early in 1978; the services of Lois Cody were engaged for this position temporarily, and the position was advertised to the Club membership. Of the three applicants, Mrs. Cody was judged to be the most suitable, and Council approved her appointment on a continuing basis. The committee recommends that the constitutional requirement of two auditors be changed to one; it also recommends that one person be appointed to be responsible for the inventory of sales of all items excluding back issues of Club journals.

(R. Taylor)

The **Membership Committee** reported that the total Club membership now stands at 1150 compared with 1163 in 1977; the membership structure is given in the table below. The Club lost a well known naturalist and Honorary Member in January 1978, when Hoyes Lloyd died. At the Annual Dinner in April, W. K. W. Baldwin was presented with an Honorary Membership. Marsh Ney, Chairman of the committee, resigned in August when he moved to Victoria, B.C.

(F. E. Goodspeed)

The **Publications Committee** reported that, since the last report, *The Canadian Field-Naturalist* was published in four issues, Volume 91(4) and Volume 92(1, 2, 3), with a total of 430 pages containing 37 articles, 46 notes, 37 book reviews, and a listing of 266 new natural history book titles. The publication was supported in part by a grant of $2200 from the National Research Council, which is very gratefully acknowledged. *Trail & Landscape* was published in five issues for a total of 152 pages of articles and information of interest to local members. Marc Forget, the Business Manager, has had to resign; we thank him for his contribution to *Trail & Landscape. The Shrike,* our local bird-watchers newsletter, was published in eight issues containing 55 pages. The committee recommended amendments to By-laws 6 and 9; submitted a grant application for $8000 to the Natural Sciences and Engineering Research Council to assist the publication of the indices to the *Transactions of The Ottawa Field-Naturalists' Club* and *The Ottawa Naturalist.* An analysis of the authorship of articles published in *The Canadian Field-Naturalist* was carried out at the request of Council. Based on a sample of issues published between 1950 and 1977, our study indicated that there had been a steady decline in the number of papers published by authors not identified with an institutional address. We emphasize *The Canadian Field-Naturalist*'s status as a major national, Canadian publication open to all workers in the field of natural history; advice and guidance are available to any author requiring assistance in documenting research results for publication.

(J. K. Strang)

During 1978 the **Excursions and Lectures Committee** organized 10 monthly meetings, with an average attendance of 30, in the auditorium of the National Museum of Natural Sciences; three photographic workshops; the Annual Dinner, with Clarence Tillenius, artist and conservationist, as speaker; and excursions covering general topics (14), birds (17), and flowers, butterflies, geology, fish, mushrooms, and microscopic life (one of each). The bus excursions are still popular and will be continued; and the use of younger members as assistant field trip leaders has been successful both as help to leaders and for training future leaders. Jeff Harrison, Chairman of the committee, resigned in May when he moved to Newfoundland.

(Jeanette Dean)

The **Conservation Committee** spent most of its time in 1978 studying and responding to *Conservation Lands in Ottawa-Carleton* and the subsequent revisions to this study. Proposed changes to the original (1974) Ottawa-Carleton Regional Official Plan included numerous boundary changes and six deletions of Conservation Areas, due in part to pressure from affected landowners. As a result of three major reports prepared by the committee, some of the revised boundaries were expanded, and two of the deleted

Membership	Canadian (local)	Canadian (other)	USA	Foreign	Totals
Individual	454 (438)	321 (342)	102 (106)	3 (5)	880 (891)
Family	198 (207)	26 (22)	1 (2)	2 (1)	227 (232)
Sustaining	9 (10)	nil (3)	nil	nil	9 (13)
Life	13 (9)	7 (6)	3 (1)	2 (2)	25 (18)
Honorary	5 (5)	4 (4)	nil	nil	9 (9)
Totals	679 (669)	358 (377)	106 (109)	7 (8)	1150 (1163)
Changes	+10	−19	−3	−1	−13

Figures in brackets represent 1977.

areas were proposed for reinstatement. During the year it became apparent that, despite The Ottawa Field-Naturalists' Club representation on advisory committees and direct communication with planning staff and politicians, without input by individual members of the Club the main viewpoint represented in response to the planning report would be that of those who were vehemently opposed to conservation zoning within the Region, as expressed at public meetings. Letters giving background to the issues were therefore sent to all local members, requesting them to write to their local politicians on the issues; there was a 10% response, which was much appreciated. Eleven field trips, to collect data, were held during the year, and it is clear that continued activity to try to influence planners and politicians will be needed for many months to come. How the committee's work will affect the status of conservation in the region is not yet known.

(Ewen C. D. Todd)

The **Macoun Field Club Committee** reported that there are 65 members in the club in this their 30th year. During 1978 consideration was given to publicizing the club, but it was decided that, rather than advertise, information about the club would be distributed to organizations where it would be readily available to those seeking such a club; local schools were also informed of the club's activities, and the members of the Senior group offered to speak to schools, and to lead Club activities, etc. A donation received in memory of John Bird, from Mrs. Furness Thompson, of Pennsylvania was used to buy a pair of binoculars for the club.

(S. Gray)

The **Education and Publicity Committee** was responsible for the acquisition and installation of a Club phone in 1978, with the number to be listed in the local directory. Other activities included providing judges for the Ottawa Science Fair, and $100 in prizes; involvement in the mail campaign for conservation support; requests for volunteers for weekday activities; and some advertising of monthly meetings in the local papers. A special field trip and scavenger hunt was organized in September for Club members and their children; it is difficult to tell whether the idea was well received as it was raining and no one came.

(Elisabeth Beaubien)

The Council has also been concerned with improving relationships both inside and outside the Club. There has been considerable discussion of the sort of relationship The Ottawa Field-Naturalists' Club should have with the Federation of Ontario Naturalists, and it was concluded that The Ottawa Field-Naturalists' Club should have Federated Club status; the election of Courtney Gilliatt to the Federation of Ontario Naturalists' Board of Directors was welcomed. Long-term discussions on the desired relationship between *The Canadian Field-Naturalist* and The Ottawa Field-Naturalists' Club have led to the recommendation that an ad hoc committee of Council be set up to study the roles of our publications and their relationship to the Club; and to produce a discussion paper on journal policies and editorial guidelines, to be brought before Council. As a result of a desire to strengthen the relationship between Council and the membership, a Council reporter was appointed, whose articles on Council activities now appear regularly in *Trail & Landscape*.

Compiled from committee reports
and Council minutes by
D. R. LAUBITZ, Recording Secretary

Auditor's Report

To: Members of The Ottawa Field-Naturalists' Club

We have examined the balance sheet of The Ottawa Field-Naturalists' Club as at September 30, 1978 and related statements of Profit and Loss. Our examination included a general review of the accounting procedures and such tests of the records and supporting vouchers as were considered necessary in the circumstances.

In our opinion these financial statements present fairly the financial position of the organization as at September 30, 1978 and the result of its operations for the period in accordance with generally accepted accounting principles.

December 2, 1978

(Signed) F. M. BRIGHAM
G.J. WASTENEYS

The Ottawa Field-Naturalists' Club Balance Sheet
as at September 30, 1978

Assets

Current			
Cash and term deposits		$ 38,240.19	
Accounts receivable		3,572.87	
Accrued interest		10,822.26	
Prepaid expenses — centennial		1,322.42	$ 53,957.74
Investments			
Canada Savings Bonds due October 31, 1978			10,700.00
Fixed at cost			
Equipment		529.50	
Less: accumulated depreciation		435.12	94.38
Total assets			$ 64,752.12

Liabilities and Surplus

Current liabilities			
Accounts payable		$ 1,506.54	
Deferred income		7,675.83	$ 9,182.37
Surplus			
Balance October 1, 1977		43,934.07	
Add: income over expenditure			
The Ottawa Field-Naturalists' Club	$ 4,155.60		
The Canadian-Field Naturalist	7,480.08	11,635.68	
Balance September 30, 1978			55,569.75
Total liabilities and surplus			$ 64,752.12

(Signed) Geoffrey Wasteneys, Auditor
F. Montgomery Brigham, Auditor
B. C. Henson, Treasurer

The Ottawa Field-Naturalists' Club
Statement of Income and Expenditure
for the year ended September 30, 1978

Income			
Apportionment of membership fees			
Annual	$ 6,642.72		
Life	720.00	$ 7,362.72	
Trail & Landscape — Subscriptions	212.00		
— Back numbers	35.00	247.00	
The Shrike — net		442.78	
Sales — decals, emblems		70.90	
		8,123.40	
Interest		2,051.99	$ 10,175.39
Expenditure			
Trail & Landscape			
Publishing	2,577.70		
Circulation	119.61		
Editing and office	54.09		
Honoraria	440.00	3,191.40	
Committee activities — net			
Excursions and lectures	(146.50)		
Membership	957.22		
Macoun Club	136.62		
Conservation	175.83		
Centennial	27.00		
Bird feeders	590.11		
Orchid survey	40.83	1,781.11	
Baldwin Scholarships	250.00		
Special activities	114.91		
Council expenses	120.00		
Office supplies	276.37		
Honorarium	200.00		
Miscellaneous	86.00	1,047.28	
			6,019.79
Excess of income over expenditure			$ 4,155.60

The Ottawa Field-Naturalists' Club
Statement of Income and Expenditure of *The Canadian Field-Naturalist*
for the year ended September 30, 1978

Income

Apportionment of The Ottawa Field-Naturalists' Club Membership Fees			
Annual	$ 4,428.48		
Life	480.00		
	4,908.48		
Subscriptions	14,737.94	$ 19,646.42	
Publication — Reprints	5,761.00		
— Plates and tab settings	2,025.50		
— Extra pages	7,897.00		
— Back numbers	1,803.73	17,487.23	
Grants — National Research Council of Canada	2,900.00		
— Canadian National Sportsmen's Show	125.00	3,025.00	
Other — Interest	2,214.11		
— Exchange	962.13	3,176.24	$ 43,334.89

Expenditure

Publishing	23,079.80		
Reprints	3,073.09	26,152.89	
Circulation		3,627.09	
Editing and expenses		1,181.23	
Office assistant		1,891.50	
Postage		896.05	
Office supplies		570.45	
Honoraria		1,502.00	
Miscellaneous		33.60	35,854.81
Excess of income over expenditure			$ 7,480.08

Instructions to Contributors

Content

The Canadian Field-Naturalist is a medium for the publication of scientific papers by amateur and professional naturalists or field-biologists reporting observations and results of investigations in any field of natural history provided that they are original, significant, and relevant to Canada. All readers and other potential contributors are invited to submit for consideration their manuscripts meeting these criteria. As the journal has a flexible publication policy, items not covered in the traditional sections (Articles, Notes, Letters, News and Comment, and Book Reviews) can be given a special place provided they are judged suitable. Readers are encouraged to support regional, provincial, and local natural history publications as well by submitting to them their reports of more restricted significance.

Manuscripts

Please submit, in either English or French, three complete manuscripts written in the journal style. The research reported should be original. It is recommended that authors ask qualified persons to appraise the paper before it is submitted. Also authors are expected to have complied with all pertinent legislation regarding the study, disturbance, or collection of animals, plants, or minerals.

Type the manuscript on standard-size paper, if possible use paper with numbered lines, double-space throughout, leave generous margins to allow for copy marking, and number each page. For Articles, provide a running head, a bibliographic strip, an abstract, and a list of key words. These items are optional for Notes. Generally words should not be abbreviated but use SI symbols for units of measure. Underline only words meant to appear in italics. The names of authors of scientific names should be omitted except in taxonomic manuscripts or other papers involving nomenclatural problems. Authors are encouraged to use "proper" common names (with initial letters capitalized) as long as each species is identified by its scientific name once.

Although we prefer the names of journals in the Literature Cited to be written out in full, these may be abbreviated following the **Bibliographic Guide For Editors & Authors**, The American Chemical Society, Washington, D.C. (1974). Unpublished reports should not be cited here. Next list the captions for figures (numbered in arabic numerals and typed together on a separate page) and present the tables (each titled, numbered consecutively in arabic numerals, and placed on a separate page). Mark in the margin of the text the places for the figures and tables.

Extensive tabular or other supplementary material not essential to the text, typed neatly and headed by the title of the paper and the author's name and address, should be submitted in duplicate on letter-size paper for the Editor to place in the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Canada K1A 0S2. A notation in the published text should state that the material is available, at a nominal charge, from the Depository.

The **Council of Biology Editors Style Manual**, 4th edition (1978) available from the American Institute of Biological Sciences, is recommended as a guide to contributors. **Webster's New International Dictionary** and le **Grand Larousse Encyclopédique** are the authorities for spelling.

Illustrations—Photographs should have a glossy finish and show sharp contrasts. Photographic reproduction of line drawings, no larger than a standard page, are preferable to large originals. Prepare line drawings with India ink on good quality paper and letter (don't type) descriptive matter. Write author's name, title of paper, and figure number on the lower left corner or on the back of each illustration.

Special Charges

Authors must share in the cost of publication by paying $45 for each page in excess of six journal pages, *plus* $5 for each illustration (any size up to a full page), and up to $45 per page for tables (depending on size). Reproduction of color photos is extremely expensive; price quotations may be obtained from the Business Manager. When galley proofs are sent to authors, the journal will solicit on a voluntary basis a commitment, especially if grant or institutional funds are available, to pay $45 per page for all published pages. Authors may also be charged for their changes in proofs.

Limited journal funds are available to help offset publication charges to authors with minimal financial resources. Requests for financial assistance should be made to the Editor when the manuscript is submitted.

Reprints

An order form for the purchase of reprints will accompany the galley proofs sent to the authors.

Reviewing Policy of *The Canadian Field-Naturalist*

Manuscripts submitted to *The Canadian Field-Naturalist* are normally sent for evaluation to an Associate Editor (who reviews it himself or asks another qualified person to do so), and at least one other reviewer, who is a specialist in the field, chosen by the Editor. Authors are encouraged to suggest names of suitable referees. Reviewers are asked to give a general appraisal of the manuscript followed by specific comments and constructive recommendations. Almost all manuscripts accepted for publication have undergone revision—sometimes extensive revision and reappraisal. The Editor makes the final decision on whether a manuscript is acceptable for publication, and in so doing aims to maintain the scientific quality and overall high standards of the journal.

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Those wishing to communicate with the Club should address correspondence to: The Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa, Canada K1Y 4J5. For information on Club activities telephone (613) 722-3050.

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Special Issue
dedicated to raptors—especially the Peregrine Falcon

Volume 90, Number 3 July-September 1976

Centennial Year

Volume 93, Number 3 **July-September 1979**

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Edward Schreyer

The objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and cooperate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

The Members of Council are listed on the inside back cover.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by The Ottawa Field-Naturalists' Club. Opinions and ideas expressed in this journal, however, are private and do not necessarily reflect those of The Ottawa Field-Naturalists' Club or any other agency.

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Cover: Since The Ottawa Field-Naturalists' Club was founded in 1879, it has published a scientific journal. Two covers are illustrated. Left, *The Ottawa Naturalist,* published from 1887 to 1919. Right, *The Canadian Field-Naturalist,* published from 1919 to the present; the format with a photograph on the cover was introduced in 1970.

The Canadian Field-Naturalist

Volume 93, Number 3 July-September 1979

To a Bigot

For years you have been telling us about the supreme importance of your laboratory studies in biology and we *have* been convinced that your research is making contributions to scientific knowledge. But we have also listened, sometimes with considerable repressed anger (because we know it is useless trying to argue with you: "Don't confuse me with facts, my mind is made up!") as you denigrate any studies dealing with natural history. Unfortunately, despite our vehement, logical protests, you refuse to hear the other side of the story but remain adamant, being dogmatically convinced only of the correctness of your own beliefs and opinions. You think further that investigations on whole animals or plants are merely diversions from what you consider to be worthwhile science. But then you are not alone because there are many others like you.

Why am I writing this editorial? Well, I hope to warn others about your bigotry, especially because you are often in a position to influence or make decisions regarding the research and careers of field-biologists. Indeed, I have often heard you dismiss the merits of scientists' publications as of "little scientific value" because they were concerned with ecology, life history, taxonomy, or distribution of animals and plants, and were published in "just naturalists' journals." You downgrade the worth of field-biologists but are firmly and smugly convinced of your own worth.

In your narrow-mindedness you automatically equate the total amount of a research grant with the scientific worth of the researcher. We think you are wrong. Everyone recognizes that some types of research are very costly but these studies are not necessarily, and often are not, the most valuable and significant. If a researcher can carry out his studies with a grant of x dollars, why should he ask for $3x$ or $30x$ dollars other than to gain more prestige in the eyes of people like yourself? Some projects do not require grants of thousands and thousands of dollars for very expensive materials and equipment. Fortunately some research, and it is often excellent research, can be done by dedicated naturalists and field-biologists with a minimum of funds or even none at all. Logically, value judgments should be made on the work accomplished and not on the size of the grants.

If you look at history, you'll find that some outstanding scientists carried out first-rate science both in the laboratory and field with a minimum of technical help and materials. "Oh yes," you'll say, "but times have changed." Molecular biology, and studies of the physiology and biochemistry of small bits of living protoplasm or ultrastructures are the "in" fields but for these research projects (like yours) is good funding absolutely essential, even at the expense of other biological research? How often have persuasive and persistent people like you convinced granting bodies and governments to fund your research at enormous expense and cared little for those who ask for a small share. In fact, when you think certain mission-oriented or applied problems are more acceptable, haven't you slanted your research grant proposal towards some aspect of cancer, energy, food production, or the environment in order to increase your chances in the competition for available funds?

Some of us have been trained and have worked in your discipline as well as in field biology and consequently we have an understanding of both these branches of biology. You, however, know only one. Although we doubt you'll ever listen, you should be aware that knowledgeable and broad-minded biologists recognize the importance of *all* good biological research. Of course we understand that you value your studies highly but we cannot, and will not, accept your narrow-minded view that your researches are inherently a cut above others, especially natural history and field studies. There is no doubt in our minds that investigations of plants, animals, and whole communities are of the utmost importance. The more we learn about ecosystems and the more we discover how plants and animals have adapted to their changing environments, the better we will be able to conserve and manage our renewable natural resources, and to make predictions for the future. On the other hand, as you learn in your research more and more about less and less, how can you even begin to understand most of the natural world?

No doubt you won't read this editorial because *The Canadian Field-Naturalist* to you is "just another naturalists' journal," not a laboratory-oriented one and in your eyes doesn't rate. But I hope other field-biologists and naturalists will add their voices to mine so that in the end we will be able to counteract and destroy the false premises on which your bigotry is built.

LORRAINE C. SMITH
Editor

Seasonal Growth, Food, and Feeding Habits of Young-of-the-year Black Crappie in the Ottawa River

JOHN MARK HANSON and S. U. QADRI

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Hanson, John Mark and S. U. Qadri. 1979. Seasonal growth, food, and feeding habits of young-of-the-year Black Crappie in the Ottawa River. Canadian Field-Naturalist 93(3): 232–238.

In the Ottawa River, during the first growing season, young-of-the-year Black Crappies (*Pomoxis nigromaculatus*) attained an average total length of 68.4 mm and a mean weight of 4.03 g. The length-weight relationship was log WT = –4.84 + 2.97 log TL. Young-of-the-year Black Crappies fed mostly on copepods and cladocerans from June to September but switched to amphipods in October. They are diurnal in habit and feed mostly on organisms in the mid-waters of the littoral zone.

Key Words: growth, food organisms, feeding behaviour, Black Crappie, *Pomoxis nigromaculatus*, juveniles, copepods, amphipods, seasonal variations, Gatineau, Quebec, Ottawa River.

Black Crappies, *Pomoxis nigromaculatus*, in the Ottawa River are at the northern limit for the species (Scott and Crossman 1973); the fish are restricted to downstream of the Chaudière Falls (McAllister and Coad 1974). Throughout its range in the United States little information is available on growth and feeding of young-of-the-year. In Canada, the feeding biology of the adult fish has been studied only by Keast and Webb (1966) and Keast (1968).

The purpose of the present study was to investigate the seasonal growth, food, and feeding habits of young-of-the-year Black Crappies in the Ottawa River.

Methods and Materials

The study site was a section of the Ottawa River, Kettle Island Bay, a long narrow bay, 5 ha in area (75°39′0″N, 45°28′8″W). The average depth of the area studied was 3 m and the maximum was 6 m. The bay is unique in that the sand is overlain with silt and decaying detritus. The river current near the bay mouth has an average velocity of 0.63 m/s (R. G. Warnock, University of Ottawa, unpublished data) but the current inside the bay depends on wind direction and velocity. The water temperature at the surface for May to October is given in Figure 1. Water hardness was 25–50 mg/L, oxygen 6–9 mg/L, carbon

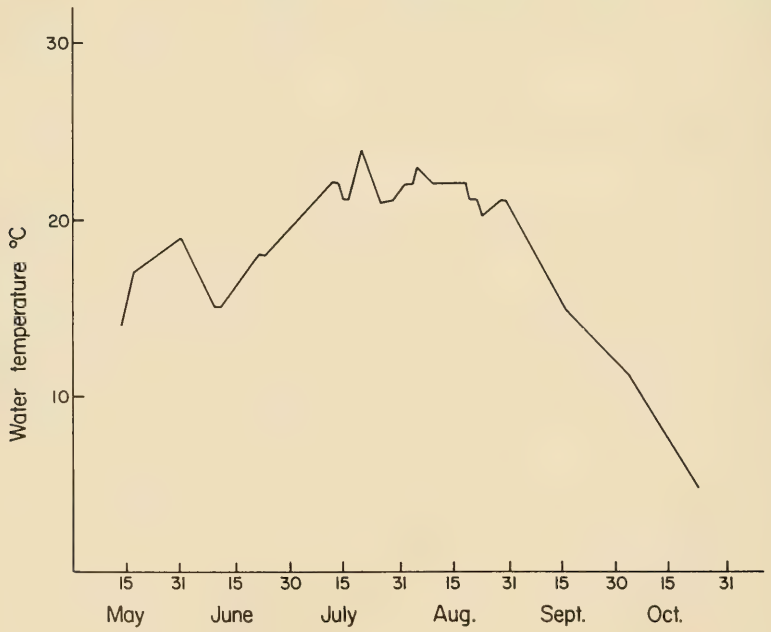

FIGURE 1. Water temperatures for Kettle Island Bay in 1977.

dioxide 8–15 mg/L, and pH 7.1 ± 0.3; suspended solids vary greatly.

In the bay, emergent vegetation consists of *Sagittaria latifolia*, *Scirpus* sp., and *Polygonum* sp.; dense stands of *Elodea* sp. and *Ceratophyllum* sp. with scattered *Potamogeton* spp. occur from 0.2 to about 1.5 m; *Potamogeton* spp. and *Nymphaea* sp., with *Elodea* sp. and *Ceratophyllum* sp. growing underneath, occur on the two humps (at 1.5 and 2.0 m) and from the sandbar to the south shore on the eastern end of the bay. This sandbar is flanked by thick beds of *Vallisneria* sp.

Sampling for Black Crappies was done by towing a green 6.35-mm mesh seine, 1.83 by 30.5 m. One end was fixed on shore as the other was towed out from shore and back by a boat with a 20-HP outboard motor. From the 2000 or more young captured on each sample date, only 30–35 were kept; these were sampled for lengths (mm), weight (g), scales, and stomach contents. Sampling was done at 2-wk intervals from May to October of 1977 and about 300 young were randomly selected for detailed examination. Organisms from the stomachs of fish captured in the field were identified (mostly at order level) and the number of organisms per fish, percent frequency, and percent volume were compiled on a monthly basis.

Total length (mm) was used throughout. For comparison to other studies, conversion factors for fork length and standard length were obtained as follows: SL = 0.8302 TL − 0.3206 (based on 71 individual measurements) and FL = 0.94 TL + 0.0135 (Figure 2). Wet weights were taken to the nearest 0.01 g. The anterior scale radius was measured with an ocular micrometer (40 ×) and reduced to actual size in millimetres. Fulton's condition factor was calculated for each fish. The significance of the difference of sample means was determined by a *t*-test.

Food and feeding habits of young Black Crappies were observed in the field and in the aquarium. From late June to early August, 10 young-of-the-year Black Crappies were maintained in an aerated all-glass aquarium, 61 × 30.5 × 30.5 cm. City of Ottawa water (pH 6.9–7.2, hardness 40–50 mg/L) was kept at 22 ± 1°C. Substrate from Kettle Island Bay was planted with *Vallisneria* sp., *Potamogeton* sp., and *Ceratophyllum* sp. Lighting was from fluorescent lights and sunlight.

In order to determine what foods could be eaten, food preferences, and feeding chronology, the fish in the aquarium were fed the following: Brine Shrimp (*Artemia salinas*) nauplii, cladocerans, copepods, amphipods (*Hyallela azteca*), free-swimming nematodes, dipteran (*Chironomus* sp.) larvae, white worms (*Enchytraeus albidus*), vestigial winged fruit flies (*Drosophila melanogaster*), newborn Guppies (*Poecilia reticulatus*), and shiner (*Notemigonus crysoleucas* and *Notropis* spp.) fry. The young crappies were observed for 1 h after the food was introduced.

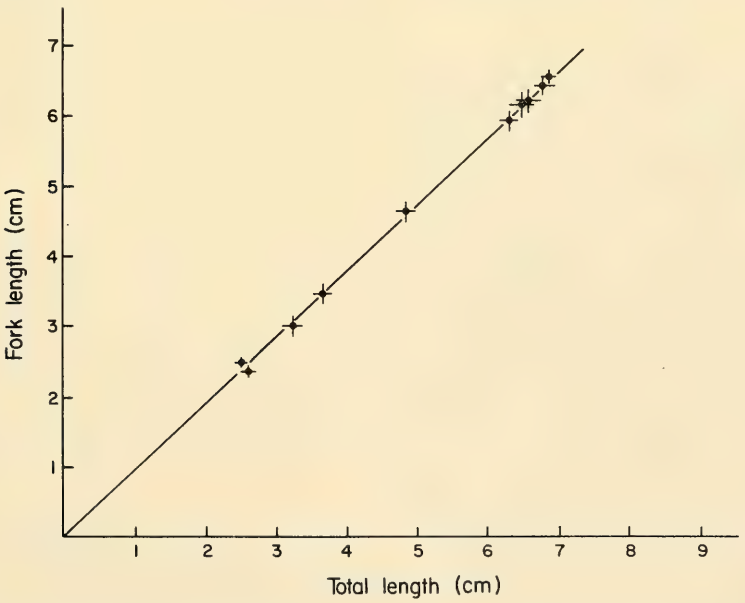

FIGURE 2. Relationships of fork length to total length of young-of-the-year Black Crappies in 1977. FL = 0.9443 TL + 0.0135. Averages of lengths with 95% confidence limits are shown.

Results

Large numbers of young-of-the-year Black Crappie were captured near the *Elodea* and *Ceratophyllum* beds until October when the weeds disintegrated and the young moved into deeper waters. During the study period all sizes of Yellow Perch (*Perca flavescens*), Northern Pike (*Esox lucius*), Largemouth Bass (*Micropterus salmoides*), Pumpkinseed (*Lepomis gibbosus*), Rockbass (*Ambloplites rupestris*), Brown Bullhead (*Ictalurus nebulosus*), Golden Shiner (*Notemigonus crysoleucas*), Emerald Shiner (*Notropis atherinoides*), and Silvery Minnow (*Hybognathus nuchalis*) were captured consistently, but in varying proportions, with the Black Crappies. The first batch of young Black Crappie was captured 20 June 1977.

The mean length of the first sample of young Black Crappie was 25.5 mm and rapid growth occurred until mid-August when growth in length slowed to a value of 68.4 mm (Figure 3). The length-weight relationship (Figure 4) is exponential with a slope of 2.98.

Rapid growth in weight occurred from July to late September (Figure 5) and slowed to a mean value of 4.03 g. The mean condition factor was 1.30 (Figure 6) except for early August when the value of 1.01 is significantly ($P < 0.005$) lower than adjacent values.

Scales appeared on fish at about 25 mm in length, weighing an average of 0.23 g. The relationship between length and the anterior scale radius (Figure 7) is given by Scale Radius = 0.1094 TL –0.1023, showing direct proportionality for young-of-the-year Black Crappies.

Table 1 summarizes, by month, the food items taken by young Black Crappies in Kettle Island Bay. The percentage of empty stomachs was always less than 9 and the stomachs containing food were usually at least half full. Copepods occupied 48 to 90% of stomach volumes from June to September but were only 13% of the volume in October. Cladocerans occurred to a maximum of 50% of stomach volume in September but only 4% by volume in August. Amphipods occurred maximally at 57% of the volume in October.

Under conditions of high winds and/or roiled water, young Black Crappies could not be observed feeding. On very bright days, very few young Black Crappies were observed feeding within 30 cm of the surface, except in direct shade. Otherwise there was no observed preference for position in the water column.

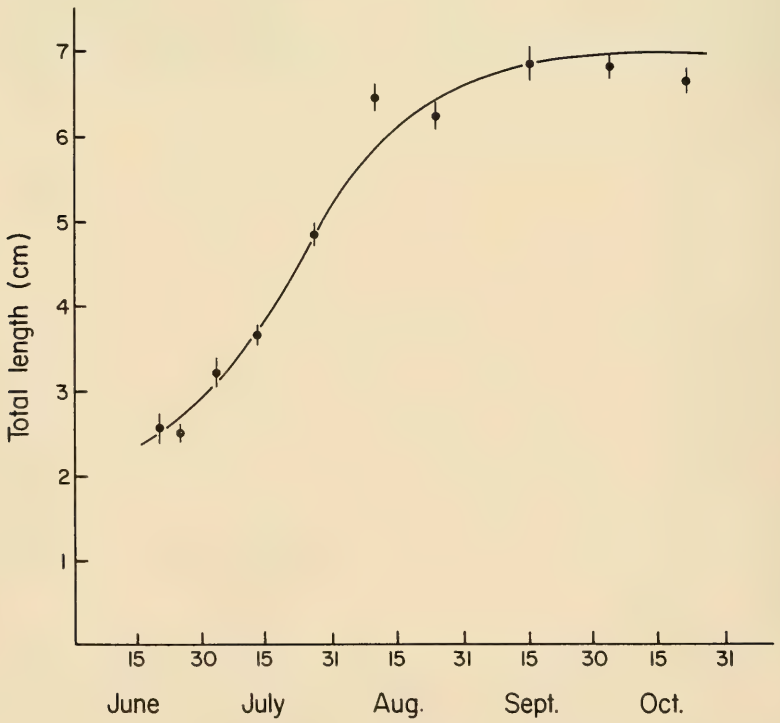

FIGURE 3. The increase in length of young-of-the-year Black Crappies during the summer and fall of 1977. Averages and 95% confidence limits are presented. Curve fitted by eye.

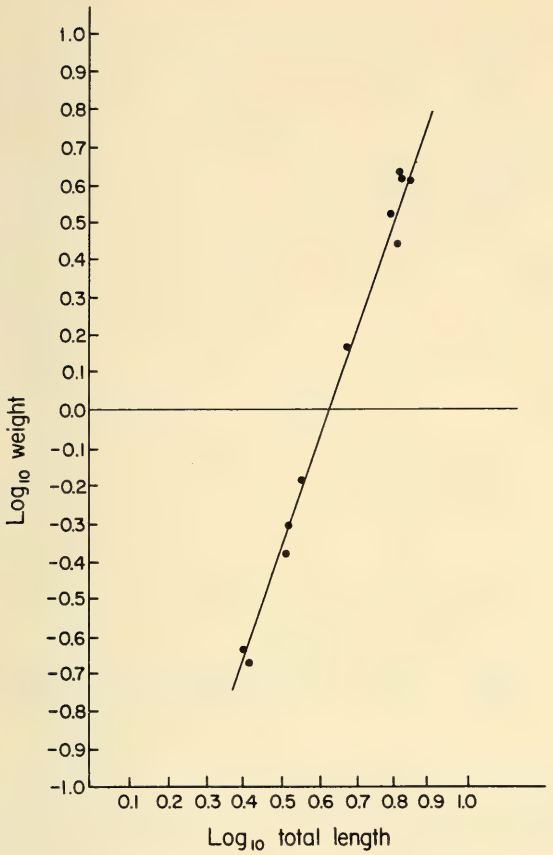

FIGURE 4. Length-weight relationship of young-of-the-year Black Crappies in 1977. log WT = –4.84 + 2.965 log TL. Length in millimetres, weight in grams.

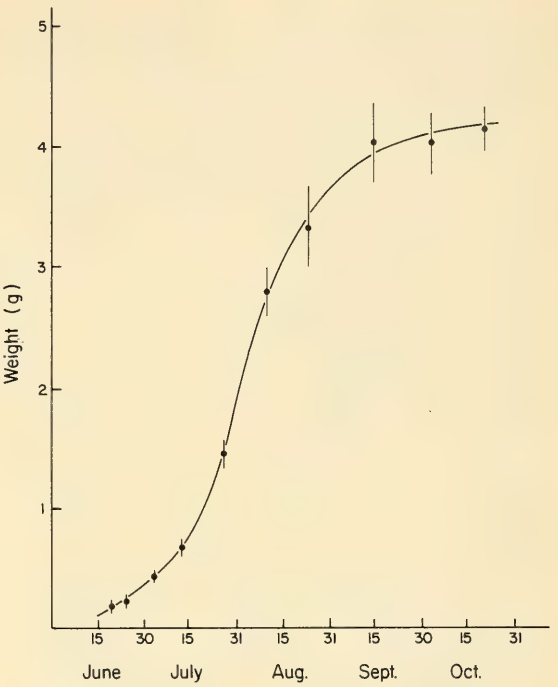

FIGURE 5. The increase in weight of young-of-the-year Black Crappies during the summer and fall of 1977. Averages and 95% confidence limits are presented. Curve fitted by eye.

During the feeding studies in the aquarium it was noted that after sunset the young crappies remained motionless near the bottom either in a corner or among the vegetation. Only nematodes were entirely ignored, although dipterans that reached the bottom and amphipods that clung to weeds usually escaped. Brine Shrimp nauplii were most readily consumed. The agility of newborn Guppies made them difficult to capture. All other foods offered were eaten within the hour of observation.

Discussion

The mean total length of 68 mm for the first growing season for Black Crappie in the Ottawa River is comparable to values of 61 to 69 mm in Minnesota (J. H. Keuhn, unpublished data; Moyle and Burrows 1954) and 68 mm in South Dakota (J. T. Shields, unpublished data; Vanderpuye and Carlander 1971) but are far smaller than those fish in southern ponds (130–200 mm, Tucker 1973) and lakes (47–91 mm, Erikson 1952). The northern growing season is shorter and food is less abundant than in the more eutrophic southern waters.

The length-weight relationship has a slope of almost 3.0 and it does not vary significantly from this value throughout its range (Table 2). The fairly consistent condition factor (Figure 6) supports the argument that body proportions of the young crappies were constant during the study period. The significant decrease in condition in early August occurred after a 2½-wk period of unusually cold, wet, windy weather during which the young Black Crappies were inactive. Contrary to our findings, Neal (1963) found that temperature and water levels did not affect the growth of Black Crappies in Clear Lake, Iowa. The shorter growing season in the Ottawa River would tend to exaggerate any condition affecting growth. Table 3 shows that young-of-the-year Black Crappies have essentially the same condition factor throughout the range.

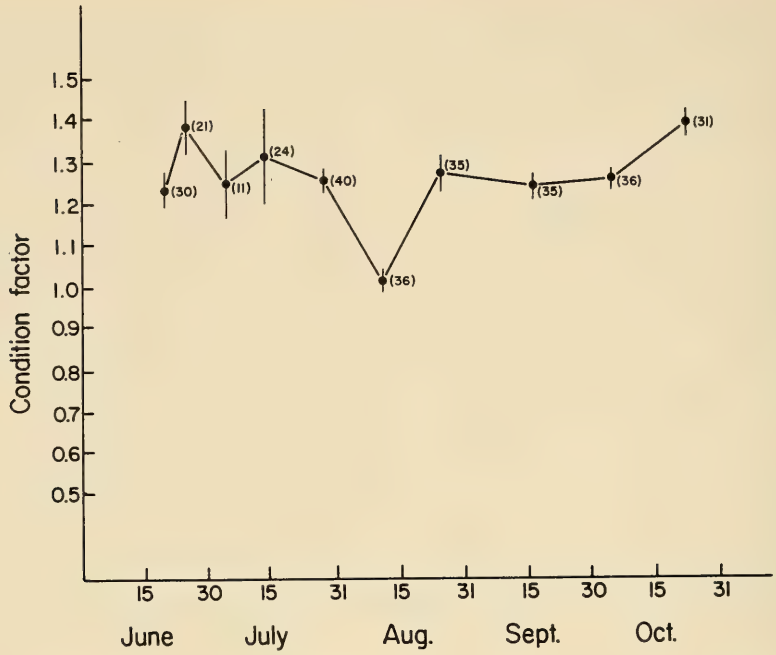

FIGURE 6. Condition factor of young-of-the-year Black Crappies during the summer and fall of 1977. Averages and 95% confidence limits are presented. Sample size is in parentheses.

TABLE 1—Percent volume (above), percent occurrence (center), and number of prey items per fish (below) of the stomach contents of young-of-the-year Black Crappie in 1977

	No. examined	% empty	Total vol. (mL)	Copepods	Cladocerans	Amphipods	Dipterans	Ephemeropterans	Hemipterans	Odonatans	Trichopterans	Fishes	Miscellaneous
				54.00	19.33	—	10.00	—	—	—	—	16.67	—
June	51	5.88	0.150	84.31	88.24	—	25.49	—	—	—	—	3.92	1.96
				18.6	6.6	—	0.314	—	—	—	—	0.078	—
				56.76	38.20	0.84	2.26	0.64	—	—	0.64	0.64	—
July	75	6.67	1.547	93.33	81.33	6.67	18.67	5.33	—	—	6.67	2.67	—
				137.2	92.0	0.133	0.333	0.053	—	—	0.080	0.160	—
				90.51	3.64	0.85	4.27	0.22	—	0.32	0.19	—	—
August	71	2.82	3.160	90.14	43.66	5.63	26.76	4.23	—	4.23	4.23	—	9.86
				555.3	76.2	0.183	1.352	0.042	—	0.070	0.070	—	—
				48.22	50.17	—	1.20	—	—	0.41	—	—	—
September	35	2.90	1.245	94.30	94.30	—	11.40	—	—	5.70	—	—	9.86
				108.6	86.40	—	0.286	—	—	0.118	—	—	—
				12.78	13.94	56.92	1.25	0.46	0.009	7.57	—	—	6.97
October	67	8.96	2.152	43.28	44.78	62.69	13.33	1.49	1.49	11.94	—	—	1.49
				71.60	60.40	9.10	0.239	0.015	0.015	0.328	—	—	—

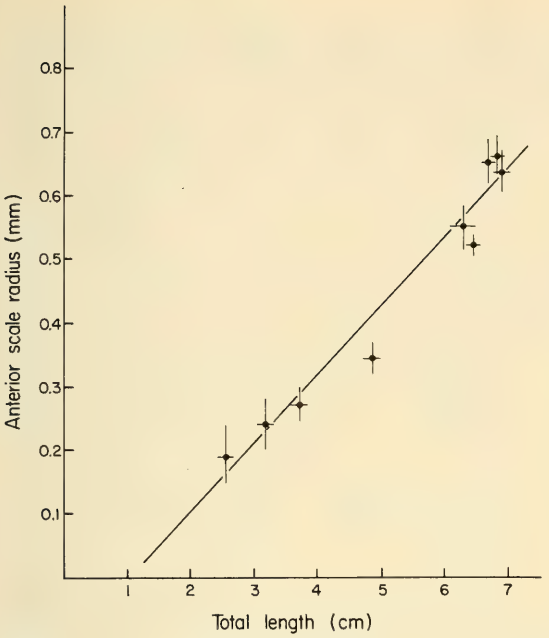

FIGURE 7. The relationship of total length to the anterior scale radius for young-of-the-year Black Crappies in 1977. Scale radius = 0.1094 TL −0.1203. Averages and 95% confidence limits are shown.

The body length to scale radius relationship was directly proportional as was found for young crappies in South Dakota (Vanderpuye and Carlander 1971) and in Iowa (Erikson 1952). Later year classes may or may not have direct proportionality (Carlander 1977).

The food eaten by young Black Crappies does not seem to vary much throughout its distribution. Pearse (1919) and Ewers (1934) reported that young Black Crappies ate copepods and cladocerans in early stages, with a progression to insects. Amphipods were not an important food item in either of these studies but the number of fish examined was small and some of the fish may have been yearlings. The destruction of the weedbeds, notably *Elodea* sp., in October seems to account for the increased availability of amphipods as a food item. This was also reflected in the increased numbers of odonatans taken at the same time. The relative unimportance of dipterans in the diet can be attributed to their benthic habits and mostly nocturnal movements and the diurnal feeding habits of young Black Crappies. Mathur and Robbins (1971) found that young White Crappies (*Pomoxis annularis*) are diurnal and eat much the same food items as young Black Crappies. Although Reid (1949) reported that Black Crappies in Florida do not eat fish until they are about 80 mm long, Burris (1956) found a 25-mm individual that had eaten a fish fry. In this study, a small percentage of Black Crappies from 25 to

TABLE 2—Length-weight relationships of young-of-the-year Black Crappies from various sources

Location	Total length (mm)	Length-weight relationship	Source
Alabama	Young-of-the-year	log WT = −4.710 + 2.914 log TL	Tucker (1973)
Oklahoma	15–56	log WT = −5.659 + 3.351 log TL	Burris (1956)
South Dakota	Young-of-the-year	log WT = −5.252 + 3.198 log TL	Nelson (1974)
South Dakota	Young-of-the-year	log WT = −5.019 + 3.075 log TL	Vanderpuye & Carlander (1971)
Ottawa River	25–68	log WT = −4.835 + 2.97 log TL	Present study

TABLE 3—Condition factor of young-of-the-year Black Crappies from various sources

Location	Total length (mm)	Condition factor	Source
Alabama	50–155	1.21	Swingle (1965)
Alabama	Young-of-the-year	1.00–1.45	Tucker (1973)
Oklahoma	15–56 (hatchery fish)	0.79	Burris (1956)
Minnesota (standard)	—	< 1.05 (poor) 1.22–1.50 (average) > 1.88 (excellent)	Carlander (1944)*
Ottawa River	25–68	1.30	Present study

*Unpublished data with Minnesota Bureau of Fisheries Resource Investigations Report 41, revised, 40 pp., typewritten (*quoted in* Carlander 1977).

33 mm long ate fry. Both shiner fry and newborn Guppies were eaten in the aquarium but the agility of the Guppies suggests that shiner fry, too, may soon become too difficult for young Black Crappies to capture under natural conditions.

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Nesting and Food-Storage Behavior of *Peromyscus maniculatus gracilis* and *P. leucopus noveboracensis*

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Tadlock, C. Craig and Harold G. Klein. 1979. Nesting and food-storage behavior of *Peromyscus maniculatus gracilis* and *P. leucopus noveboracensis*. Canadian Field-Naturalist 93(3): 239–242.

In a laboratory study we compared the nesting and food-storage behavior of *Peromyscus maniculatus gracilis* and *P. leucopus noveboracensis* (Rodentia: Muridae) given a choice between upper and lower nest-boxes. *Peromyscus l. noveboracensis* preferred upper nesting locations while *P. m. gracilis* showed no significant preference between upper and lower nest-boxes, although more lower nest-boxes were used. These results agree with those of a previous field study on the ecological distribution of these subspecies where both inhabited an upland forest habitat providing both tree- and ground-holes. *Peromyscus l. noveboracensis* stored significantly more food and tended to build heavier nests than *P. m. gracilis*. This may be related to the higher preferred ambient temperature for *P. l. noveboracensis* and its more southern geographic distribution as compared to *P. m. gracilis*. Where these subspecies occur in the same habitat, competition between them may be minimized because of differences in height-preference for nesting and food-storage.

Key Words: *Peromyscus*, nesting, food-storage, height-preference, interspecific competition, sympatry, behavior, ecological, geographical, physiological.

Previous studies have shown that the Deer Mouse, *Peromyscus maniculatus gracilis*, and the White-footed Mouse, *P. leucopus noveboracensis*, are occasionally found living within the same woodland habitats of northeastern United States and southeastern Canada (Klein 1960; Smith and Speller 1970). Smith and Speller (1970) found both taxa cohabiting an upland forest habitat in southeastern Ontario while an adjacent mixed forest and a cedar forest were occupied only by *P. m. gracilis*. They observed that a significantly greater number of *P. l. noveboracensis* ran up trees when released from traps, compared to *P. m. gracilis*, which generally ran to ground refuges. Because there were probably more tree-holes in the upland forest than in the other forest habitats, one hypothesis presented by these authors was that *P. l. noveboracensis* occurred in the upland forest because it could find refuge in the tree-holes present. The lack of tree-holes in the mixed and cedar forests prevented inhabitation by *P. l. noveboracensis* because of competition by *P. m. gracilis* for ground-holes.

The objective of this study was to determine whether a difference in nest-height preference occurs between these subspecies under laboratory conditions. Differences in food-storing and nest-building behavior, which might contribute to ecological separation of these taxa, were also investigated.

Material and Methods

Seven adult male *Peromyscus m. gracilis* and 10 adult male *P. l. noveboracensis* were live-trapped within 40 km of Plattsburgh, Clinton County, New York, and were individually housed in plastic cages ($25 \times 10 \times 15$ cm) for 2–5 mo prior to testing. The animals were housed and tested in a windowless, air-conditioned room maintained at $20.6 \pm 2°$ C and with a 13 light:11 dark cycle. A 7.5-W light provided dim illumination during the dark phase. Food pellets (Agway Charles River Rat and Mouse Formula) and water were provided *ad libitum*.

The test apparatus was a modified version of one used by Klein and Layne (1978). It consisted of a pressed-board (Masonite) box $60 \times 60 \times 122$ cm. Eight removable nest-boxes ($16 \times 14 \times 14$ cm) with removable tops were attached to the outside of the box, with four nest-boxes at each of two levels. Circular entrance holes (5-cm diameter) to the upper and lower nest-boxes were located 98 and 4 cm, respectively, from the floor of the apparatus. Access to each upper nest-box was provided by a transversely-grooved wooden stick which extended obliquely within the apparatus from its floor to the nest-box entrance hole. The apparatus had a removable pressed-board floor and a wire mesh (7.5 mm) cover. The floor of the apparatus was covered with a 7.5-mm layer of a clay-based cat-box absorbent litter (Poise). A food-dish and water-bottle were centrally located. Two types of nesting material were provided. Pieces of paper-towel material (13×2 cm) and pieces of non-surgical absorbent cotton (2 ± 0.5 g) were scattered on the apparatus floor at the beginning of each test period.

Each mouse was tested for a 7-night period. The 10 *P. l. noveboracensis* were tested consecutively prior to testing the seven *P. m. gracilis*. Between tests of the two subspecies, the entire apparatus was washed with

a mild ammonia solution and allowed to air-dry for a period of 5 wk. Between tests of individual mice, the apparatus was cleaned with warm water and the locations of the nest-boxes were randomized. We believe that these procedures eliminated any attraction or avoidance responses by the test animals to specific nest-boxes or nest-box levels. The results were inspected for any evidence of selection of previously used nest-boxes by the test animals; none was found.

On Day 1, at approximately 6 h into the light phase of the daily cycle, each animal was put into the apparatus through a lower-level entrance hole. On Days 2 through 7, at about 6 h into the light phase, the following data were recorded: location of mouse, location of nest(s), location and number of food pellets, and location and number of feces. On Day 8, at 4 h into the light phase, the animal was removed from the apparatus. In addition to the above data, the weights of the nests and stored food were recorded. The apparatus was cleaned and a new mouse was introduced.

Results

Every mouse visited each of the eight nest-boxes, as determined by the presence of feces in the nest-boxes. Maximum-minimum thermometer data indicated no difference in temperature between upper and lower nesting levels, eliminating this factor as a possible explanation for the nesting patterns observed in this study.

Peromyscus l. noveboracensis exhibited a clearcut preference for upper nest-boxes but *P. m. gracilis* individuals were divided in their choice of nest-box level (Table 1). Individually, the mice of both taxa were highly consistent in their nestbox-level selection during the 7-night period. None nested at both levels of the apparatus and each mouse could be classified as either an "upper" or "lower" nester (Table 1).

Nest construction was similar in both subspecies. All nests were constructed of shredded cotton; no paper-towel material was incorporated into any of the nests. The nests were all built in a spherical form, with a small cavity in the center and with two openings.

A comparison of the nest weights of the two subspecies, regardless of level, indicated a tendency for *P. l. noveboracensis* nests to weigh more than *P. m. gracilis* nests (Table 1), but the difference was not significant (Mann-Whitney U test, $P = 0.094$). This was caused partly by the great variability in nest weights, which ranged from 17.9 to 76.2 g in *P. l. noveboracensis* and from 9.5 to 53.2 g in *P. m. gracilis*. A comparison of the nests built in the upper boxes showed that *P. l. noveboracensis* nests were significantly heavier than *P. m. gracilis* nests (Table 1). No significant difference was found between weights of upper and lower nests of *P. m. gracilis* (Mann-Whitney U test, $P = 0.228$).

Eight of the 10 *P. l. noveboracensis* constructed only one nest during the study period and these nests were used in calculating the mean nest weight (Table 1) in order to make it comparable to the mean nest weight for *P. m. gracilis,* which was calculated from seven single nests. The other *P. l. noveboracensis* individuals built two and three nests each within the 7-night period, respectively. Each of these nests weighed less than the mean weight of the eight single nests, and their weights were not included in the calculation of the mean nest weight because of this bias.

Food stores were usually independent of nests. Only one *P. m. gracilis* stored food in its nesting-box. Five *P. l. noveboracensis* stored food in their nesting-boxes; of these, four individuals had additional food stores, from three to six each. *Peromyscus l. noveboracensis* stored significantly more food than *P. m. gracilis* (Table 2). Intrasubspecific comparisons of weights of food stored in upper versus lower boxes showed no significant differences in either subspecies (Table 2). Although there was a tendency for *P. l. noveboracensis* to store more food in upper than in lower boxes, and for *P. m. gracilis* to store more food

TABLE 1—Summary of nesting data for mice of each subspecies nesting at each nest-box level during the 7-night study period

Subspecies	Nest location	Number of mice nesting	Nest weight (g) Mean ± SE	Weight of all nests for each subspecies (g) Mean ± SE
P. m. gracilis	Upper	4	13.8 ± 2.37*	24.4 ± 6.3
	Lower	3	34.0 ± 12.29	
P. l. noveboracensis†	Upper	10	35.6 ± 6.7 *	35.6 ± 6.7
	Lower	0	— —	

*Difference between these weights was significant at $P = 0.016$; Mann-Whitney U test (Siegel 1956).
†Only eight single nests were used for calculating mean nest weights. See text for explanation.

TABLE 2—Summary of food-storage data for mice of each subspecies storing food at each nest-box level during the 7-night study period. N = 7 for *P. m. gracilis;* N = 10 for *P. l. noveboracensis*

Subspecies	Food-store location	Mean number of food-stores	Weight of food stored at each level (g)	Weight of total food stored by subspecies (g)
			Mean ± SE	Mean ± SE
P. m. gracilis	Upper	1.1	9.58 ± 5.84**	28.13 ± 10.90*
	Lower	2.6	18.55 ± 5.65	
P. l. noveboracensis	Upper	2.2	45.46 ± 13.94**	75.84 ± 17.38*
	Lower	2.2	30.38 ± 15.54	

*Difference between these values was significant at $P < 0.05$; Mann-Whitney U test (Siegel 1956).
**Difference between these values was significant at $P = 0.018$; Mann-Whitney U test (Siegel 1956).

in lower boxes, these differences were not significant (Table 2). A comparison of food-storage between the subspecies at each level showed that in the upper boxes *P. l. noveboracensis* stored significantly greater weights of food than *P. m. gracilis* (Table 2). In the lower boxes, the weights of food stored by *P. l. noveboracensis* were not significantly higher than those stored by *P. m. gracilis.*

Discussion

The three variables (nest-height preference, nest weight, and amount of food stored) measured in the artificial environment of our study indicated a significantly greater usage of upper nest-boxes by *Peromyscus l. noveboracensis* compared to *P. m. gracilis.* With respect to nest-height preference, the choice of upper nest locations by *P. l. noveboracensis* was unquestionable; a preference for upper-level food storage sites, although not significant, was relatively strong. This agrees with Nicholson's (1941) finding that a southern Michigan population of *P. l. noveboracensis* used tree nest-boxes (0.9 to 9.2 m above ground) to a much greater extent than ground-level boxes.

Peromyscus m. gracilis showed no significant preference for nest-box level in nesting or food storage, although heavier nests were built and more food was stored in lower boxes. The patterns of nest-box utilization by these subspecies in our artificial environment supports the hypothesis of Smith and Speller (1970) that cohabitation of these subspecies in their upland forest habitat was based, in part, on differences in the utilization of above-ground cavities. Implicit in Smith and Speller's hypothesis was the assumption that *P. l. noveboracensis* was forced to occupy arboreal situations because of competition for ground holes from *P. m. gracilis;* however, the consistent preference of *P. l. noveboracensis* for upper boxes for nesting in our study suggests that this may be a behavior typical for this subspecies. Therefore, the observed arboreal tendencies of *P. l. noveboracensis* in the Smith and Speller (1970) study may not have been a change in the behavior of this population because of competition from *P. m. gracilis.*

The lack of nest-height preference by *P. m. gracilis* in our study suggests an ability of this taxon to adjust to various nesting situations. It agrees with the widespread distribution of *P. m. gracilis* in the Smith and Speller (1970) study and the observation that *P. m. gracilis* individuals ran up trees on some occasions, although they usually retreated into ground holes. It also suggests that *P. m. gracilis* would not be a serious competitor of *P. l. noveboracensis* for arboreal nest sites except in periods of high population density in *P. m. gracilis.* The low population density of *P. m. gracilis* in the Smith and Speller (1970) study, coupled with the tendency of released mice to use ground refuges, is in agreement with this inference.

Although *P. l. noveboracensis* stored a significantly greater amount of food than *P. m. gracilis,* and *P. l. noveboracensis* tended to build heavier nests than *P. m. gracilis,* it is possible that these differences (mainly attributable to the apparent inhibition of *P. m. gracilis* in its utilization of upper nest-boxes) were not entirely behaviorally-based. The thermoregulatory function of the nest in *Peromyscus* has been well-documented (Sealander 1952; Glaser and Lustick 1975). A difference in ambient temperature preference has been experimentally demonstrated between *P. l. noveboracensis* (32.4°C selected) and *P. m. gracilis* (29.1°C selected) by Ogilvie and Stinson (1966). The differences between these preferred ambient temperatures and the ambient temperature of our study (20.6°C) were probably sufficient to elicit temperature-induced food-storing and nest-building responses in these animals. A lowered ambient temperature (7° versus 27°C) caused an increase in

food-storing behavior in *P. l. noveboracensis* (Barry 1976). An ambient temperature of 20°C elicited a maximal paper-shredding, nest-building response in *P. l. noveboracensis,* compared to the responses at 25° and 30°C (Jaslove and McManus 1972). The differences in food-storing and nest-building behavior shown by the subspecies in our study may have been differential responses to the low ambient temperature of our study relative to the preferred ambient temperatures of these taxa. The differences in preferred ambient temperature is presumably based on a physiological difference between the subspecies. Riedel (1967) demonstrated that, at low temperatures, *P. m. gracilis* survived better than *P. l. noveboracensis,* whereas the opposite was true at high temperatures.

A situation of severe competition for nest sites may exist, however, between *P. leucopus* and a closely related species, *P. gossypinus,* where they are sympatric in the northern part of the Gulf coastal plain and in the Mississippi Valley of southern United States. McCarley (1963) concluded that in this area *P. gossypinus* excluded *P. leucopus* from lowland forest habitats by interspecific competition. Competition for arboreal nest-sites may have been a major factor in this interspecific relationship. Ten male *P. gossypinus palmarius* from Florida showed a very strong preference for upper nest-boxes when tested in an apparatus similar to that of our study (Klein and Layne 1978). A direct comparison (using a similar apparatus) of the nest-height preferences and interactions of individuals from sympatric populations of *P. leucopus* and *P. gossypinus* might clarify the extent and nature of their interspecific competition.

The behavioral and physiological differences between *P. m. gracilis* and *P. l. noveboracensis* are probably based on adaptations related to the geographic-ecologic distributions of these subspecies (and their respective species). For example, nesting in an arboreal site would be more appropriate in areas of mild winter climate, whereas in areas of severe winter climate it might cause a serious thermoregulatory problem. Such a species- or subspecies-typical behavior, if unmodifiable, could be a factor limiting the geographic-ecologic distribution of the taxon. The different nest-height preferences shown by these subspecies may reflect the climatic conditions in their respective environments. Although the ranges of *P. l. noveboracensis* and *P. m. gracilis* broadly overlap, *P. l. noveboracensis* is more southern than *P. m. gracilis* in its geographic distribution and, where these taxa are sympatric, corresponding ecologic differences in local distribution generally occur (Hamilton 1943; Klein 1960; Miller and Kellogg 1955). Where cohabitation of these subspecies occurs, our study suggests that sufficient differences exist in the height-preference aspect of nesting and food-storage behavior to result in decreased competition between them.

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Life History Characteristics of Little Brown Bats (*Myotis lucifugus*) in Alberta

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Life history data of Little Brown Bats (*Myotis lucifugus*) were recorded from 1971 to 1978 during the course of a rabies study in Alberta. The study is the northern-most examination of the life history of the species to date. The number of bats that inhabited the 269 maternity colonies examined, varied from less than 15 to approximately 1100 adults. Seventy-five percent of the colonies in central Alberta were in occupied buildings. Differences in the biology of Little Brown Bats from more southern studies included later commencement of parturition, shortened period of parturition, non-breeding of juvenile females, substantial numbers of females at non-maternity shelters during mid-summer, extensive roosting at exposed locations during summer and fall, and aggregations of unknown function in abandoned buildings during fall. Adult females gained weight during and after pregnancy and in late summer, and lost weight at parturition and in late July. Juvenile males entered hibernation weighing less than adult males. Adult males were seldom located in maternity roosts but predominated at a hibernaculum.

Key Words: Little Brown Bat, *Myotis lucifugus*, life history, Alberta.

The Little Brown Bat (*Myotis lucifugus*) is one of the most widely distributed species of North American bats (Hall and Kelson 1959); its range encompasses a wide variety of habitats and climates. Latitudinal gradients in photoperiod and the duration of the seasons could induce selective pressures that might result in behavioral and physiological variation within this species. The biology of *M. l. lucifugus* in eastern North America (reviewed by Humphrey and Cope 1976) and of *M. l. occulatus* in New Mexico (O'Farrell and Studier 1973, 1975; Studier and O'Farrell 1972; Studier et al. 1973) have been extensively studied, but life history information for more northern populations of Little Brown Bats is necessary to identify and define characteristics that vary with latitude.

The initiation of a research program on bat rabies was prompted by an outbreak of rabies in Alberta in 1970 and the first diagnosis of this disease in a bat from the province in the following year. Dorward et al. (1977) reported preliminary conclusions regarding the incidence of rabies in bats from Alberta. This paper presents biological data on the Little Brown Bats collected during the course of the study. Observations were made from 49°N to 57°N, but most information was collected between 52°N and 55°N, the region commonly known as 'central Alberta.' This area is 4–6° north of studies in Ontario (Fenton 1969, 1970), approximately 11° north of studies in Indiana and Kentucky (Humphrey and Cope 1976), and approximately 14° north of studies in New Mexico (O'Farrell and Studier 1973, 1975).

The Little Brown Bats that inhabit the non-mountainous portions of Alberta have been identified as *M. l. lucifugus* (Hall and Kelson 1959; Soper 1964; Banfield 1974); however, southern Alberta is occupied by a separate form, *M. l. carissima* (Smith and Schowalter 1979). Unless otherwise indicated and with the exception of a discussion of the provincial distribution of *M. lucifugus*, the data presented here deal with *M. l. lucifugus* as it occurs in central Alberta, although some observations may be from areas of intergradation with the southern form. Also discussed are bats from a hibernaculum near Cadomin (see Figure 1) which have been previously classified as *M. l. pernox* (Soper 1964) but are indistinguishable from *M. l. lucifugus* of central Alberta (H. C. Smith, Provincial Museum of Alberta, personal communication).

Methods

Most colonies and some shelters were located through complaints of bats made to government offices by the public. Systematic surveys, responses to newspaper advertisements, and a questionnaire mailed to rural landowners provided additional locations. History sheets of bats sent to the Animal Diseases Research Institute (Western) [ADRI(W)] of Agriculture Canada at Lethbridge, Alberta for rabies testing provided the majority of the locality records for individual bats. Additional individual records were obtained from specimens at the Provincial Museum of Alberta, the Museum of the Department of Zoology at the University of Alberta, as well as

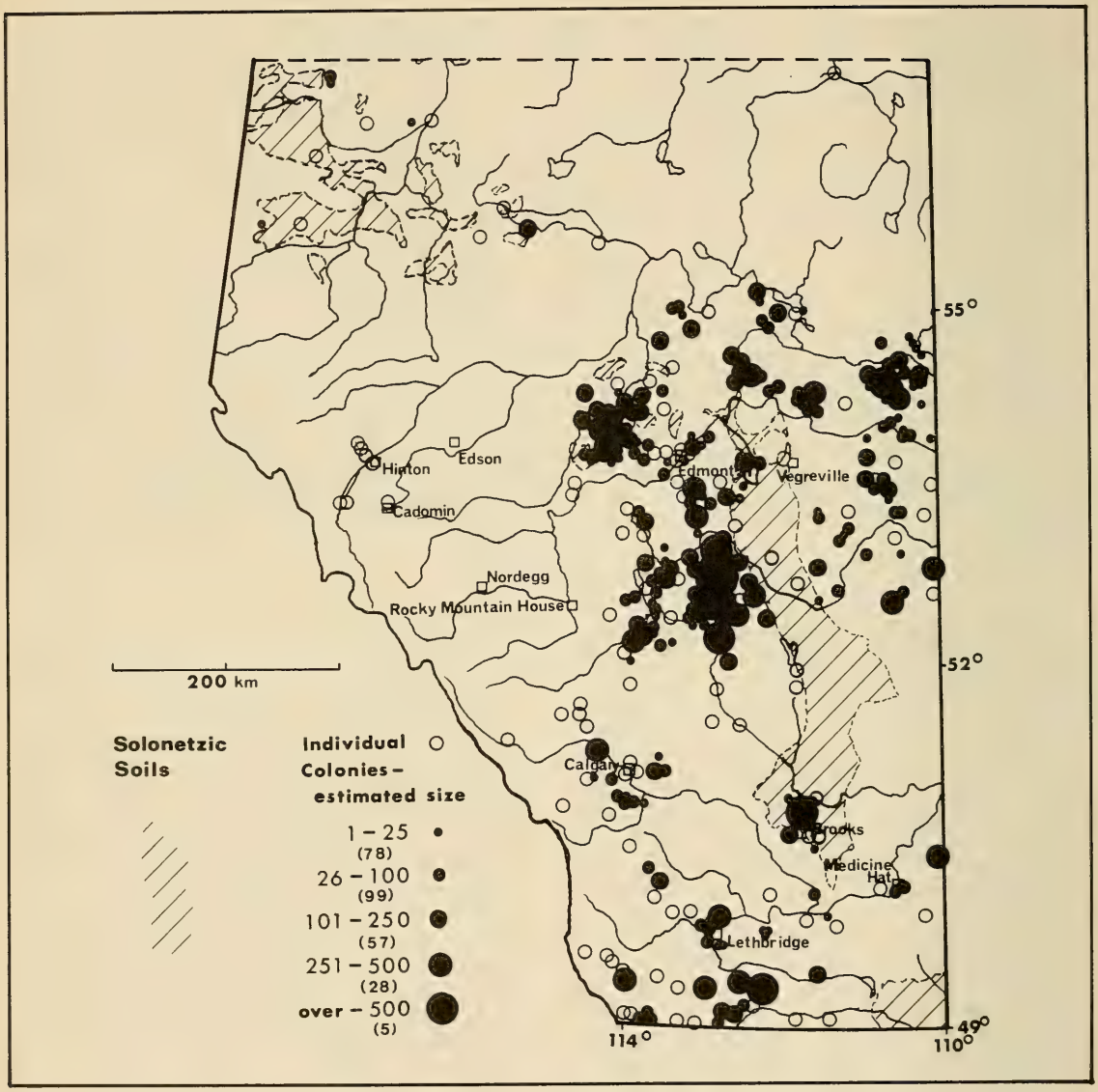

FIGURE 1. Distribution and estimated size of Little Brown Bat maternity colonies located in Alberta, 1971-1977.

from published data and our own field activities.

Most roosts were entered to identify and enumerate the bats present. Bats were periodically collected at maternity roosts for rabies testing and additional bats were captured at maternity roosts known to harbor rabies, a variety of non-maternity shelters, a hibernaculum, and by mist-netting over ponds and streams. Aggregations of bats in buildings in fall ('fall aggregations') were sampled in 1975. The following information was recorded for each bat: age (juvenile or adult) as determined by the closure of the epiphyses of the finger joints, sex, and weight. Examination of the nipples of adult female bats (Racey 1974) provided an indication of their reproductive history, and the current reproductive condition of a sample of female bats taken prior to the commencement of parturition was determined by uterine examination. The number of fetuses and the horn of implantation were recorded for pregnant females. Eight non-parous unsuckled female bats collected at shelters in mid-June were aged by dental annuli (Schowalter et al. 1978b) to determine the ages of non-breeding females.

Results and Discussion

Distribution

We examined 269 maternity roosts of Little Brown Bats. Sufficient data to determine the relative abundance and distribution of this species are available only from the more heavily settled southern and central areas of the province. Concentrations of colonies were evident in several lake-cottage developments, in certain rural areas of knob and kettle ('pothole') topography in central Alberta, and in areas of extensive irrigation development near Brooks and Lethbridge. Few colonies were located near Vegreville, where the habitat resembled that of areas with many colonies, or north of Brooks and Medicine Hat (Figure 1). Questionnaire responses, interviews with residents, and the pattern of submission of rabies-suspect bats all suggested that few Little Brown Bats are found in these regions. Silver-haired Bats (*Lasionycteris noctivagans*) (Schowalter et al. 1978a) and Hoary Bats (*Lasiurus cinereus*) (Schowalter and Dorward 1978) have been submitted to ADRI(W) from these areas with sufficient frequency to suggest that the absence of Little Brown Bats is probably not an artifact of the reporting system.

The area of low abundance of Little Brown Bats in Alberta corresponds, in part, to the distribution of solonetzic soils (Figure 1) and the distribution of grasslands (see Hardy 1967). Water bodies in solonetzic soil zones are known to support different arthropod faunas than those of other areas (Rawson and Moore 1944) and the food supply for bats in solonetzic soil areas may thus be of different quality than in other areas. Grasslands are less heavily settled and have far fewer trees than other agricultural areas and thus offer fewer potential roost sites. These factors do not, however, appear to explain completely the observed distribution of Little Brown Bats.

Maternity Colonies

Although some complaints of bats in cottages were not investigated and colonies in unoccupied buildings and natural roosts were less likely to be reported, occupied buildings were apparently favored for colony formation in central Alberta. Of the 196 *M. l. lucifugus* maternity colonies located and classified in this region, 147 were in occupied buildings and, with the exception of one colony in a tree, the remainder were in cottages, abandoned houses, sheds, and barns. Maternity roosts were typically dark and poorly ventilated and almost always subject to heating by the sun, as described by Fenton (1970) and Humphrey and Cope (1976). Most colonies occupied a single building, although bats in larger colonies appeared to use as many as six buildings. The estimated number of adult Little Brown Bats in individual maternity colonies ranged from less than 15 to 1100; between 50 and 300 was usual.

From 1972 to 1975 bats returned to the maternity roosts during the first half of May. During 1976 and 1977, years with early and mild springs, bats were reported as early as 24 April (1976) and many roosts contained bats by 1 May. The earliest date that a juvenile was taken at a non-nursery roost was 9 July (1976), but juveniles and suckled females were regularly observed at such locations only during the last week of July, indicating that nursery break-up was advanced by that time. By the second week of August most maternity roosts had few bats, but juveniles were found at this type of roost as late as 26 August (1975). Juvenile bats outnumbered adult females in our August samples from maternity colonies (69:30), indicating that adults tend to leave nurseries sooner than juveniles, as Humphrey and Cope (1976) have reported.

The sexes were equally represented in our collection of fetuses and juveniles from maternity colonies, but adult males were seldom found in these roosts (Table 1). This low occurrence of males agrees with the observation by Humphrey and Cope (1976) that males rarely frequent maternity colonies in the northern portion of the species range compared with regions to the south.

TABLE 1—The percentage of males among samples of Little Brown Bats from central Alberta: 1972–1978. Sample size in parentheses

	Percentage of males		
Sample type	Fetuses	Juveniles	Adults
Maternity roost	53 (61)	49 (395)	0.4 (807)
Shelters			
May			3 (31)
June			41 (66)
July		20 (5)	38 (13)
Aug.		31 (45)	24 (49)
Sept.		41 (106)	30 (147)
Fall aggregation		38 (8)	11 (19)
Swarming		67 (30)	80 (81)
Hibernation			78 (270)

Other species of bats were seldom encountered in Little Brown Bat maternity roosts. Three attics used by Little Brown Bats were also colonized by Big Brown Bats (*Eptesicus fuscus*). Little Brown Bats appeared to have recently colonized two of these attics after modifications to the buildings and the two species used different parts of the attics. In the third case a single beam separated the roosts of the species, but at the time of observation the majority of the Big Brown Bats were in the walls of the building rather than immediately adjacent to the Little Brown Bats. A

Silver-haired Bat was observed in one colony on 17 May (1974).

Shelters

We recognized two types of non-nursery roosts or shelters used by Little Brown Bats. Some bats persistently used concealed locations in barns, attics, log buildings, piles of lumber, and behind shutters, tree bark, and a piece of tin wrapped around a tree trunk. One banded male was observed on each of six inspections of a roost over three summers. Shelters in exposed situations, typically darkened recesses of brick buildings between 2 and 7 m above the ground, were used daily by 1 to 22 bats. There was evidently a high turnover of individuals at these locations: some property owners destroyed roosting bats daily, seemingly without reducing the number of bats using the roost. Bats banded at this type of shelter have not been recaptured at the original banding site.

More bats were collected at exposed roosts at night than during the day. Although bats roosting at shelters during the night usually became torpid, many of those that were not disturbed, aroused and departed prior to sunrise. Bats found during the day were almost always torpid.

With the exception of a male collected on 23 May 1978, all bats captured at shelters during May were females (Table 1); many had previously suckled young (Table 2) and may have been migrating to maternity colonies. Male Little Brown Bats were also poorly represented (1/24) in May submissions to ADRI(W) from Alberta and May samples from shelters in Michigan (Miller 1955). These observations probably relate to the tendency of males to depart from the hibernacula later than females (Humphrey and Cope 1976).

TABLE 2—The percentage of unsuckled adult female Little Brown Bats among samples from central Alberta: 1972–1978. Sample size in parentheses

Sample type	Period	Percentage unsuckled
Maternity roosts	Prior to 15 June[1]	17 (329)
	After 1 July[2]	18 (331)
Shelters	May	30 (30)
	June	95 (39)
	July	88 (8)
	Aug.	41 (37)
	Sept.	44 (91)
Fall aggregations	Aug.–Sept.	18 (17)

[1]Pregnant unsuckled bats taken after 15 June could have been identified as suckled.

[2]Bats which appeared to be unsuckled after 1 July are not considered likely to give birth that year.

Female Little Brown Bats were observed at shelters in Alberta proportionately more frequently than has been reported elsewhere (Table 3). The proportion of females appears to increase with latitude (Table 3), but the distance from hibernacula is known to affect the proportion of males in maternity roosts (Humphrey and Cope 1976) and may affect the sex ratio in shelters. Female Little Brown Bats that use shelters during June have been thought to be non-parous (Miller 1955; Humphrey and Cope 1976). In Alberta the majority of females taken at shelters during June were unsuckled (Table 2). None of eight females captured at shelters, whose uteri were examined was pregnant. Palpation of other female bats at shelters during June produced no evidence of pregnancy. Although sex-ratio data for bats caught at shelters (Table 1) represent observations made at varying intervals with varying effort over 5 yr, significant annual variation is assumed not to have occurred.

TABLE 3—Percentage of males among Little Brown Bats taken in shelters during June from various North American locations

Location	Latitude north	Percent males (n)	Reference
Oklahoma	35	100 (17)	Glass and Ward (*cited in* Humphrey and Cope 1976)
Indiana	39	100 (3)	Humphrey and Cope 1976
West Virginia	39	100 (40)	Krutzsch 1961
New York	42	87 (63)	Davis and Hitchcock 1965
Michigan	42	84 (85)	Miller 1955
Vermont	42	98 (648)	Davis and Hitchcock 1965
Alberta	54	41 (66)	This study

The use of shelters increased during late July with the appearance of juvenile and suckled adult female bats. The largest numbers of bats were collected at shelters around the end of August and generally declined thereafter. During August and September bats frequented roosts not used earlier in the year. Bats roosting on white buildings were easily seen from roadways and were collected by driving through business districts. Exposed roosting was observed or reported from throughout central Alberta. Bats roosting at such locations may have been migrants passing through unfamiliar areas. An adult male Little Brown Bat banded at such a shelter in Edmonton on 8 September 1977 was recaptured 5 d later near Rocky Mountain House, a movement of 173 km.

Frequent use of exposed roosts by Little Brown Bats has not been reported previously. The roosting is so obvious that it is doubtful that it would be missed by bat researchers if it occurred in their research areas. Efforts to locate bats or bat droppings at potential exposed shelters in Lethbridge and Medicine Hat did not produce evidence of bats, suggesting that the subspecies found in southern Alberta may not use exposed roosts. The behavior and transience of bats at shelters were similar to those of the Cave Bat (*Myotis velifer*) at 'transient colonies' in early spring and late autumn in Kansas (Kunz 1974). This behavior is thought to be important in reducing metabolic expenditure and in migration. In central Alberta we have taken a few Keen's Bats (*Myotis keenii*) and Big Brown Bats at shelters used by Little Brown Bats, and Silver-haired Bats are frequently encountered by window washers in exposed situations on higher buildings in Edmonton. As similar observations in other areas are not known to us, exposed roosting in central Alberta may be important in thermoregulation, possibly in response to unidentified climatic factors.

Fall Aggregations

We have observed concentrations of 500 or more Little Brown Bats in buildings on three occasions during late August and early September. All of the buildings used by these 'fall aggregations' were abandoned and unheated, but the bats were not torpid during the day. Local residents reported that one of these buildings had been used by bats during several autumns. The predominance of heavy female bats in two small samples (Table 1, Figure 2) suggests that fall aggregations may be related to migration rather than to breeding. Humphrey and Cope (1976) noted evidence of "autumn dispersal and transient nursery visitation" distinct from swarming which takes place at caves. Fall aggregations in Alberta may be part of the same phenomenon noted by Humphrey and Cope (1976), but few data are available on activity of Little Brown Bats away from caves at this time of year.

Weight Dynamics

Adult female Little Brown Bats gained weight during pregnancy, after parturition, and prior to hibernation (Figure 2). Weight losses occurred as a

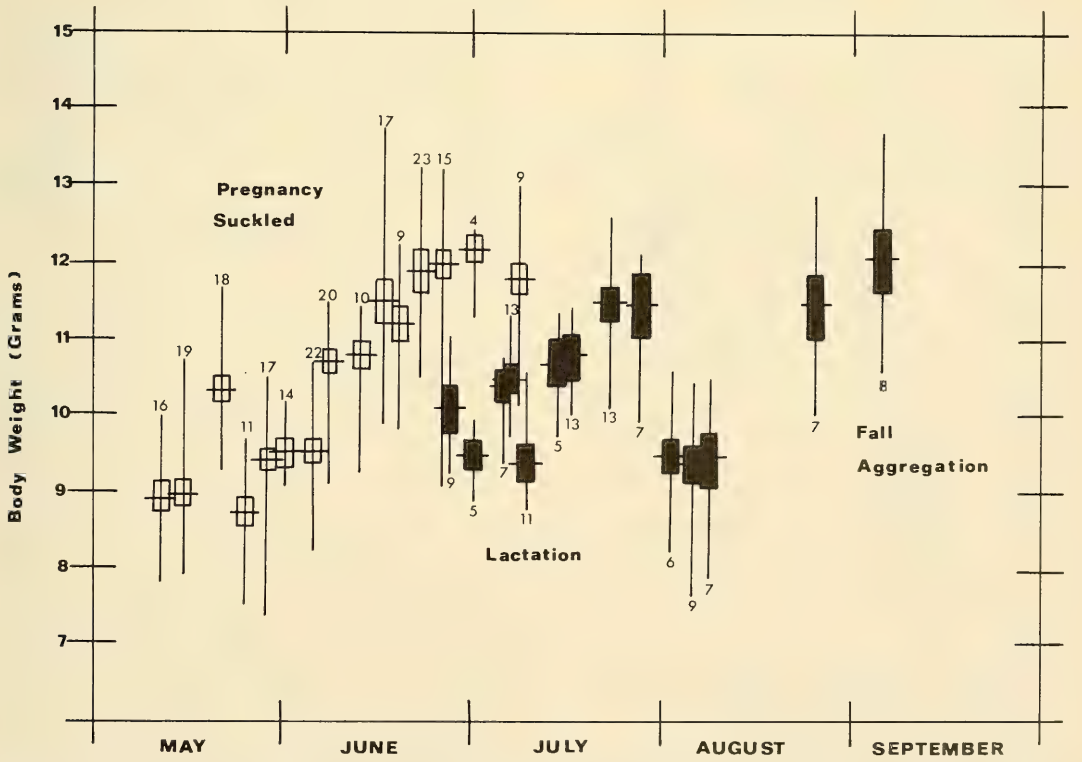

FIGURE 2. Seasonal variation in body weight of adult female Little Brown Bats in central Alberta (mean ± SE, range), 1971–1977.

result of parturition and from unknown causes at the end of July, at least among females in maternity roosts. Data from Ontario (Fenton 1970) are comparable to those presented here, but they do not extend into August, so that it is not known whether the weight loss observed at that time is general for the species.

Juvenile Little Brown Bats gain weight rapidly until late July (Figure 3). Stomachs of juveniles examined at that time contained insects only, insects and milk, or milk only, indicating that weaning had begun, Weights are less consistent after that time, suggesting that juveniles may lose some weight after colony break-up. A collection on 20 August (Figure 3) included many juveniles that appeared to be starving and were of low weights.

Swarming and Hibernation

A preponderance of males was netted at the mouth of Cadomin Cave during September 1977 (Table 1), a finding that is similar to observations elsewhere (Davis and Hitchcock 1965; Hall and Brenner 1968; Fenton 1969; Humphrey and Cope 1976). Swarming may have ended at Cadomin Cave between 20 and 27 September 1977 as only four individuals were captured on the later date. This change was probably not caused by weather as Long-legged Bats (*Myotis volans*) were captured in greater numbers on 27 than on 20 September.

Juvenile bats captured on 20 September 1977 at Cadomin Cave weighed significantly less (t-test, $P<0.01$) than juveniles at shelters in Edmonton and Edson on 19 and 20 September (Table 4). Weights of adult males in the two samples were nearly identical. Too few adult females were captured at Cadomin Cave to allow comparison. Juveniles may have lost weight in moving to the cave from maternity roosts, whereas the distance moved by adult males from the summer range may have been less, as suggested by the observations of Humphrey and Cope (1976). The mean weight of adult males at Cadomin was significantly greater (t-test, $P<0.01$) than that of juvenile males, indicating that juveniles likely enter hibernation weighing less than adults.

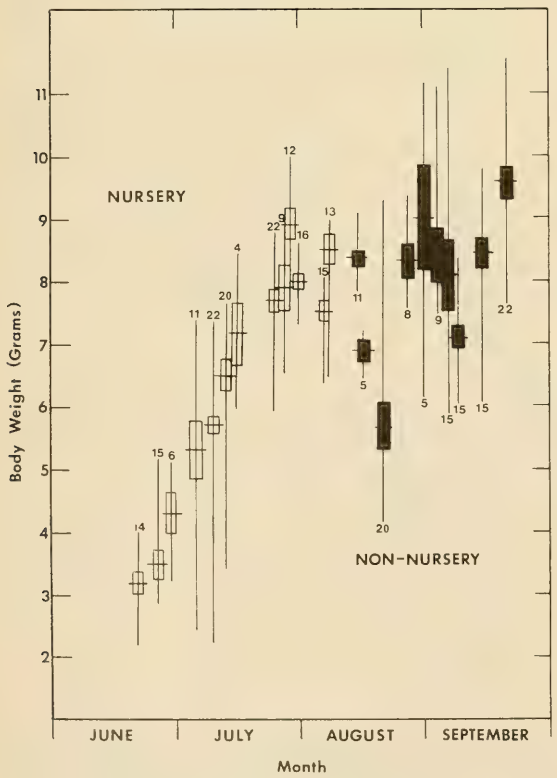

FIGURE 3. Seasonal variation in body weight of juvenile Little Brown Bats in central Alberta (mean ± SE, range), 1974–1977.

TABLE 4—Mean weights (± 95% confidence intervals) of Little Brown Bats captured at shelters in Edmonton and Edson and at Cadomin Cave 19–20 September 1977. Differences tested by Student's t-test

Location	Juvenile females	Juvenile males	Adult males
Cadomin	8.7 ± 0.4 (7)	8.6 ± 0.4 (17)	9.8 ± 0.2 (44)
Shelters	9.9 ± 0.5 (16)	9.2 ± 0.6 (10)	9.7 ± 0.2 (13)
	$P < 0.01$	$P < 0.02$	$P < 0.8$

The earliest and latest dates that we have found numerous bats hibernating were 20 September 1977 and 15 May 1975, respectively. Fifteen bats captured on the spring date were all males, which suggests that most or all females may have left the hibernaculum. The sex ratio of hibernating bats favored males (Table 1) and was similar to that reported elsewhere (Humphrey and Cope 1976).

The locations of the hibernacula of most Little Brown Bats found in Alberta are unknown despite inspection of mines and caves and continuing liaison with caving organizations. The only suitable areas for hibernacula within the province are in the Rocky Mountains and a large area of karst in the northeast of the province. The numerous coal mines of the central and southern portion of the province, which would likely offer potential hibernacula, have been routinely blasted shut in accordance with provincial law. Three hibernacula were located: Cadomin Cave and a cave near Nordegg, both in the Rocky Mountains, over-

winter between 500 and 1000 bats, and a third cave in Wood Buffalo National Park in the northeast contains a small number of hibernating Little Brown Bats. Many bats would have to travel 450 km from maternity roosts to reach either of these areas.

Reproduction

Of the 183 adult female Little Brown Bats collected in maternity roosts prior to the onset of parturition (15 June), 91% were pregnant. Twin fetuses were observed twice among 312 pregnancies; 290 of the single fetuses had implanted in the right horn. The incidence of pregnancy among 162 bats that had previously suckled young (95%) was significantly higher (χ^2 test, $P<0.001$) than that among 21 unsuckled females (52%). Pregnant, unsuckled bats generally weighed less than pregnant, suckled females and they carried fetuses that often appeared smaller than those of suckled bats. Three of eight unsuckled bats caught in nurseries during mid-July were resorbing embryos.

The earliest neonate was observed on 15 June 1975 and the latest date a pregnant bat was captured was 15 July 1976. Parturition appeared to be highly synchronous both within and between colonies as reflected in the relatively consistent patterns of weight gains of pregnant females and juvenile bats (Figures 2, 3) even though the samples were taken from colonies in a variety of buildings and over a broad geographical area. Based on fetal inspections and observations of neonates, the majority of the bats born in 1972 through 1975 were born during the last week of June. Parturition tended to commence earlier during 1976, possibly owing to the early arrival of adult female bats at the maternity roosts. Greater variation in fetal and juvenile development was noted during that year. Limited observations during 1977 indicated similarity with 1976.

Like the females of many temperate-zone vespertilionids (Asdell 1964), the majority of female *M. l. lucifugus* in central Alberta do not bear young as yearlings. Schowalter et al. (1978b) reported that yearling bats comprised a smaller than expected proportion of the 90 adult female bats in a nursery in central Alberta and that all of the yearlings present were non-parous. All eight of the unsuckled, non-parous females from shelters that we have aged by counts of dental annuli were young of the previous year. Non-parous yearling bats probably comprise the majority of the unsuckled bats found both in maternity colonies and at shelters in central Alberta (Table 2).

Juvenile Little Brown Bats are thought to be reproductively active in New Mexico (O'Farrell and Studier 1975) and Indiana (Humphrey and Cope 1976) as non-parous females were almost entirely absent. Davis and Hitchcock (1965) found 11 of 21 yearling Little Brown Bats (aged by closure of finger epiphyses) examined in New England to be pregnant, suggesting that nonbreeding by juvenile females may tend to increase with latitude. This may account for the tendency for the increased proportion of females in shelters in June with increased latitude (Table 3).

Differing timing of events both within the year and within the life of individual female bats parallels increased latitude. Later commencement of parturition in Little Brown Bats with increased latitude is well documented (Fenton 1970; Humphrey and Cope 1976). O'Farrell and Studier (1975) have also observed that the period of parturition becomes abbreviated in more northern populations. Both these trends are evident in comparisons of data from central Alberta with those available from areas to the south.

In southern Alberta, which has a frost-free period that is approximately 20 days longer than in central Alberta (Government and University of Alberta 1969), parturition of *M. l. carissima* is estimated to extend from at least as early as mid-June to the first of August, a much longer period than in *M. l. lucifugus* in central Alberta. Determination of mean parturition date of *M. l. carissima* was not possible from the limited samples as parturition was highly variable within and between colonies and between years; however, parturition in 1975 and 1976 was later there than in central Alberta. A collection made south of Lethbridge on 12 July 1976 included seven lactating and nine pregnant females, and two volant young. Pregnant females were taken at the same colony 21 July 1975. Observations at this colony in July 1977 indicated that most young were born by at least mid-July of that year. Visits to other colonies in the region also indicated variability of parturition. The longer, later, and more variable period of parturition in southern Alberta may relate to minimal confrontation with cold weather on the maternity range and to the longer warm season which would, in many years, allow late-born bats sufficient time to prepare for hibernation.

O'Farrell and Studier (1975) related a brief parturition period of *Myotis thysanodes* to synchrony of departure from hibernacula. Although it is possible that most female Little Brown Bats found in central Alberta follow this pattern, the geographic extent of the region and the number of bats involved suggest that this is not a complete explanation of the brief parturition period observed. Female bats may return to maternity roosts before food is abundant and temperatures are favorable to take advantage of the earliest arrival of favorable conditions. Low temperatures are known to slow fetal development in some bats (Racey 1973; Studier and O'Farrell 1972; Studier et al. 1973) and fetuses may tend to be at a similar

stage of early development at the time of arrival of warm weather, regardless of the date of arousal from hibernation and arrival at the colony of the females. In years with mild early springs fetal development in arriving females would not be slowed and an earlier, more variable parturition period would result, as observed in 1976. Whereas the gestation period of early-arriving females may tend to be extended by cool conditions in early May, gestation periods of late-arriving females may be shortened by the comparatively high temperatures during long daylight periods that are characteristic of late June. These considerations suggest that the relative abbreviation of the parturition period observed in Alberta, while probably adaptive to bats living at higher latitudes, may largely be a response to environmental conditions rather than a specific regional adaptation of bats.

The results described here were not obtained through research designed specifically to examine bat life-history. Detailed examination of a single colony or local population rather than examination of many colonies over a large geographical area would clarify details of phenology and growth patterns. Little Brown Bats occur far north of the present study area and study of such boreal populations would identify adaptations to exceedingly long daylight periods. The trends identified here may be more evident in those populations.

Acknowledgments

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Winter Denning of the Striped Skunk in Alberta

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Winter denning of the Striped Skunk *(Mephitis mephitis)* was studied in Alberta and adjacent Saskatchewan between 1971 and 1977. Most skunks denned under buildings and for periods up to 150 d. Skunks denned in communes and alone. Communal dens contained a number of female skunks (mean of 5.8 per den) and usually one adult male skunk. Solitary dens were occupied by males only, usually juveniles. Range of numbers of skunks in 61 communal dens was 2–19. Available comparative data suggest commune size increases with latitude, an adaptation to optimize winter survival and reproductive success. Age-specific selection seemed to operate in some communes with juvenile females excluded from certain dens. Juvenile males visited den sites in fall, but only rarely denned with female communes.

Key Words: *Mephitis mephitis,* Striped Skunk, denning, communes, sex, age.

The Striped Skunk (*Mephitis mephitis*) dens for extended periods during winter (Allen and Shapton 1942; Dean 1965; Verts 1967). More recent studies of denned skunks during winter have explored the potentials of disease transmission (Houseknecht 1969), activities (Sunquist 1974), physiological and behavioral adaptations (Mutch and Aleksiuk 1977), and habitat selection (Mutch 1977). We observed winter denning of skunks during 1971–1977 in studies of skunk rabies in Alberta and adjacent Saskatchewan (Gunson et al. 1978) and in an intensive population study of skunks in central Alberta (Bjorge 1977). This paper summarizes observations of den descriptions, numbers, sex and age, periods skunks spent in dens, and of movements to and from dens, and considers the adaptive significance of these aspects of winter denning of skunks near the northern limit of the species distribution.

Study Area

Most dens were located in the Alberta–Saskatchewan border area where the bulk of rabies-related work was conducted (Figure 1). The area is aspen parkland (Bird and Bird 1967) in the northern half and prairie (Webb et al. 1967) in the southern half. It was settled between 50 and 100 yr ago and current land use has been in effect for many years. Cattle ranching and dry-land farming predominate in the short-grass prairie and cereal grain production and mixed-farming in the parkland. The climate of the study area is continental, characterized by warm summers and cold winters (Government and University of Alberta 1969). Variations in annual precipitation and number of frost-free days from north to south were $\simeq$ 28/18 cm and $\simeq$ 100/130 d.

The 130-km^2 intensive study area (Tofield), located $\simeq$ at 53°23′N, 112°43′W, appeared typical of the aspen parkland. Eight major forested areas (mostly Trembling Aspen, *Populus tremuloides*), ranging 30–65 ha, occurred as well as numerous smaller areas with trees and brush along fence rows, road allowances, farmyards, and wetlands. About 150 ponds, many of them seasonal, dotted the area. Predominant crops were cereal grains, forage, livestock, and poultry. Of 112 farmyards on the study area, 40 were abandoned.

Methods

Dens were located during six winters (1971–72 to 1976–77) primarily by visual examination of likely locations such as old buildings, culverts, and ground burrows. When located, skunks were removed from dens chiefly by carbon-monoxide gassing with two 2-cycle gasoline-operated motors, shooting (22-calibre rifle), and kill-trapping with mostly 220 Conibear traps. Collection of all skunks was often possible through removal of floorboards or occasionally by jacking or digging under foundations. Only dens examined during November to March, and only those dens where collectors were convinced all skunks were captured, were used in calculations of numbers and of sex and age.

Skunks were live-captured at Tofield during the non-winter period by trapping (National, Rudolph Skunker, and wooden and metal box traps were used), night-lighting (Jacobson 1969), and excavation of maternal dens. Live-captured skunks were handled according to the techniques of Jacobson et al. (1970) including netting, ear-tagging, weighing, sexing, and release. Radiotransmitters, similar to those used by Brand et al. (1975) and developed by personnel of the Department of Electrical Engineering, University of Alberta, Edmonton, were fitted to skunks. Signals were received via a truck-mounted non-directional whip antenna or a hand-held directional loop antenna and a portable receiver. Locations were determined by triangulation.

FIGURE 1. Locations of 61 communal dens of Striped Skunks in prairie and parkland portions of Alberta and adjacent Saskatchewan.

Dental ages of collected skunks were determined by counts of cemental annuli in canines (Rakowski 1972; Casey and Webster 1975) after histological preparation at Matson's Audiovisual and Microscopic, Milltown, Montana. Live-captured young of the year were classified as juveniles until 31 December on the basis of weight, nipple development, and general appearance.

Results and Discussion

Location and Description of Dens

Our searches for winter dens were directed primarily at rural, usually abandoned, buildings; thus the precise proportional use of buildings versus burrows, culverts, and other possible locations during winter was not determined. Of 73 communal (>1 skunk) dens, 72 were located under buildings; one was in a culvert. Of 44 solitary (1 skunk) dens, 37 were under buildings, five were in culverts, and two were in ground burrows. Five of the six culvert dens were located in the southern prairie region. Both ground burrows were located at Tofield after extensive searching and tracking in snow during early winter 1971–72. The relatively large number of female skunks (see next section) under some buildings and the availability of other buildings without skunks, but used during previous winters, suggested that most female skunks, especially in the parkland, denned under buildings.

During a depopulation at Tofield in December 1974, 19 (53%) of 36 female skunks tagged during June to October of that year were removed from six communal dens. Depopulation was incomplete at one den and skunks could not be removed from one other potential communal den because of its concrete structure. The above, and probable losses from death and emigration between summer and winter, support our belief that the majority of female skunks in the parkland den under buildings. Comparable recapture rate at buildings for males was only 11.9%, suggesting that many male skunks den in locations other than buildings. Of the two ground burrow dens located, one was used by a tagged male; the sex of the skunk in the other burrow was not determined.

Related research (Gunson et al. 1978) implied relatively heavy skunk use of buildings during winter in the parkland versus prairie. Skunk depopulations by poisoning at buildings effectively reduced skunk populations in the parkland, but not in the prairie.

Use of buildings as winter dens of skunks appeared greater in our study area than that recorded in more southerly areas. Allen (1939) and Storm (1972) reported that buildings were used only occasionally by skunks in Michigan and Illinois, respectively. It may

be that buildings were more available to skunks in our area than in other areas. Larger commune size and lower densities (unpublished data) of skunks in our area compared to more southerly areas probably favored the selection of building dens. A preference for building dens would result in greater proportions of skunks utilizing such dens in areas or periods of lower density. Building dens offer skunks more space for walking and use of latrines and for breeding during years of longer winters.

Skunks made use of the space between ground and floorboards in most building dens. All winter dens that we observed contained dried vegetation, mostly grass. Ground burrows, usually associated with cellars, were present under some buildings. Construction of burrows was likely necessary in some cellars to create a more confined den area.

Numbers, Sex, and Age of Skunks in Dens

A mean of 6.7 skunks was collected from 61 communal dens where collectors were convinced all skunks were taken (Table 1). Females were more common in communal dens than males; in fact, no den contained more than one live male. Allen (1939) noted that only one male was present with denned females in his area. We obseved 43 dens of solitary males; denning by solitary females was not observed. Dens of solitary males and females were reported by Allen (1939) and Allen and Shapton (1942) in Michigan.

TABLE 1—Composition of 61 communal winter dens of the Striped Skunk in Alberta and adjacent Saskatchewan (dens where all skunks were collected)

Sex	Number of skunks	
	Total	Mean (range)/den
Females	353	5.8 (1–18)
Males	53	0.9 (0– 1)
Both sexes	406	6.7 (2–19)

Somewhat more skunks were taken from communal dens in parkland versus prairie (means of 6.8 of 32 dens and 6.4 of 29 dens, respectively (Student's t-test, $P < 0.4$)). The largest commune was located in Township 57, the most northerly den we observed. Comparable data from other areas, although meagre, suggest commune size increases with latitude. Shirer and Fitch (1970) working in Kansas noted three skunks denned together, but for only short periods during winter. Numbers of skunks in dens was 2 to 11 in 10 dens (mean of 5.1) in Michigan (Allen 1939; Allen and Shapton 1942), two to six per den in Minnesota (Houseknecht 1969; Sunquist 1974), and eight in one den in Colorado (Yeager and Woloch 1962).

Larger communes in more northerly areas are likely an adaptation of the species to more rigorous climates. Mutch and Aleksiuk (1977) demonstrated that den temperatures vary directly with numbers of skunks in the den. It follows that females in larger groups would expend less energy in surviving longer winters, during which they do not feed, and conserve more energy for reproduction. Length of winter importantly influences production of skunks. Litters of young skunks at Tofield were significantly larger (Student's t-test $P<0.05$) in 1973 (mean of 5.2) after a relatively mild winter compared to size of litters following the severe winter of 1973–74 (mean of 2.5) (Bjorge 1977).

Juvenile (<1 year) females represented 47.7% of 327 aged females (Figure 2). In contrast, juvenile

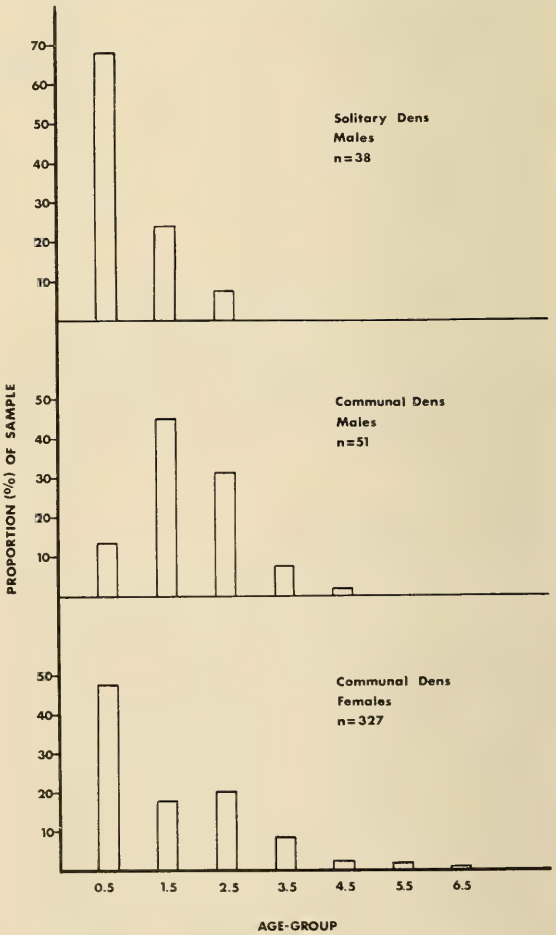

FIGURE 2. Age-structure of Striped Skunks in solitary and communal dens in Alberta and adjacent Saskatchewan.

males comprised only seven (13.7%) of 51 aged males in communal dens. Most of the lone males were young; 26 (68.4%) of 38 aged solitary males were juveniles. No lone male was over 3 yr of age.

Comparisons of age structures of skunks in populations during summer and fall and in communal winter dens at Tofield (Table 2) indicated that the juvenile proportion in the female cohort was somewhat similar in dens and free-ranging skunks. Juvenile males, however, although common (> 60%) in male cohorts in populations, were absent in six communal dens during winter. In summary, winter dens of the Striped Skunk in our area included communal denning of females, usually with one adult male, and solitary denning of other males, including most juveniles.

TABLE 2—Comparisons of age structures of Striped Skunks in six communal dens and in populations on the Tofield, Alberta study area

Source	Period	Proportion (%) juveniles (n)	
		Male	Female
Communal dens	1974–75	0 (5)	47 (32)
Population[1]	1974	66 (41)	35 (34)
Population[1]	1971–74	62 (134)	37 (140)

[1]Live-trapped during June through October; excludes captures at communal dens in September and October.

Den Formation

Live-trapping at Tofield during September through October 1971–74, indicated that male skunks visited winter den sites other than the one they would occupy. From two to three male skunks were captured at each of six sites at which communes were forming during fall. Because only one male winters at each commune a male selection process must occur. Much of the selection might be a result of avoidance, probably juveniles tending to avoid more experienced adults. At each of two sites in 1974, adult and juvenile males were captured at the den site in fall; only the adults were present with the female commune in winter. Some competition, involving fighting, probably occurs during the fall pre-denning period. Three males with fresh scars on ears and face were observed during that period.

Some unsuccessful (solitary) males visited communal dens during winter. A farmer poisoned a male skunk at one communal den in southern Alberta in late February. During the first week of March four live skunks, including one male, were collected at the den. We believe it highly probable that the second male joined the commune after the death of the former male. Tracks of skunks to and from dens were common during that collection period. At each of two other communal dens one live and one dead male skunk were collected. During a thaw in February 1972, at Tofield, a solitary male visited a commune 1 km from his burrow.

Data from Tofield suggested that occupation of a specific communal den by females in at least some cases probably depended on age and experience. Five of seven females at one winter den at Tofield were adults, only one of which was a yearling. R.R.B. considered this area to have a higher density of skunks than most of the remainder of the Tofield area. At least four of the eight skunks at that winter den were captured and tagged during 1973 and 1974 at another den site used the previous three winters, but not in 1974–75. All or most of the group moved some 2.5 km to the new winter den during the fall pre-denning period in 1974. An adult male wintered alone at the original den. These observations suggest the commune was highly cohesive, and may explain the observed relatively low proportion of juveniles. Other young females may have been forced to den elsewhere. We noted that two other communes changed dens between years.

Another communal den of seven females, located in an area R.R.B. considered to be of low skunk density, consisted of six juveniles and one yearling. We collected some evidence that suggested these were not siblings. First, as discussed later, juvenile females at Tofield were highly mobile, travelling many kilometres to communal dens (Bjorge 1977). If such extensive dispersal of juvenile females is common it is unlikely that siblings would den at the same location. Second, of 62 young skunks, including 27 females, tagged in natal dens in 1973 and 1974, none was recaptured in communal dens on the study area even though survival of young was demonstrated at seven of 15 dens. Survival was not recorded at the other natal dens. Allen (1939) concluded that winter groups of female skunks in his area were not families.

Juvenile proportion of females in 56 communes was not bimodally distributed (Figure 3) as one might have expected from the selection process outlined above. Selection against juveniles at some dens could potentially create a situation of most dens with either low or high proportions of juveniles. Thirty-three (59%) of 56 dens contained < 30% or > 60% juveniles. Many of the dens in our sample were located in areas where skunks were being depopulated for rabies control. Because skunk sign was more abundant and more readily observed at communal dens than at solitary dens, skunks were more likely to be discovered and poisoned at communal dens. Higher than normal mortality at communal dens may account for

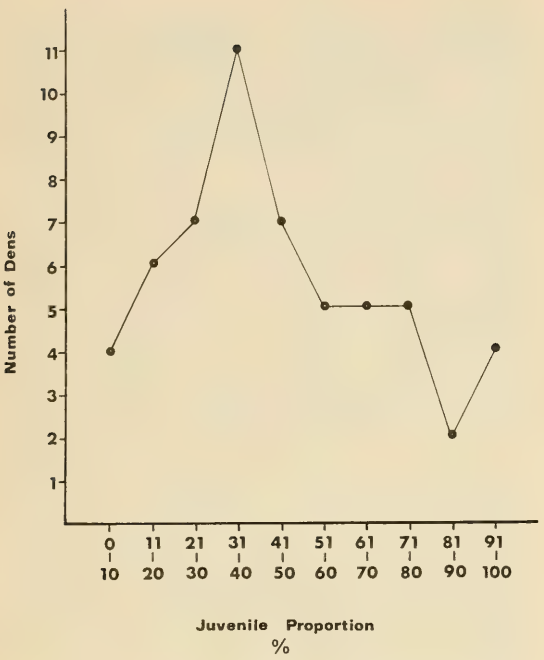

FIGURE 3. Juvenile proportion of female Striped Skunks in 56 communal dens in Alberta and adjacent Saskatchewan.

the variation between observed and expected distributions. Juveniles might be more readily accepted into dens of reduced size.

Denning Period

Success of live-capture at sites of communal dens at Tofield increased from 69 and 124/1000 trap-nights in July and August, respectively, to 275 in September; skunks began to harvest vegetation around den entrances in late September, as observed by Sunquist (1974) in Minnesota. This seemed to represent a pre-denning activity as skunks were still free-ranging during September and October, as evidenced by success of night-lighted captures along roads (Gunson et al. 1978) and by live-capture success at non-denning sites at Tofield. Adult skunks likely began denning before juveniles. Night-lighted captures of free-ranging skunks during late September and October were highly biased towards juveniles (unpublished data), and mean distances of adult females from communal dens at Tofield during September and October were significantly (Student's t-test $P < 0.05$) less than for juveniles. Live-capture at communal den sites was most successful in October (306/1000 trap-nights). Sunquist (1974) noted that juveniles were more active than adults in November and initiated winter denning an average of 7 d later than adults. In 1973 activities of skunks beyond the immediate vicinity of winter dens at Tofield were terminated by a 25-cm snowfall on 10 November.

Observations at 10 occupied dens during winter 1971–72 indicated that activity beyond a few metres of the den did not occur during early December to mid-February. A marked increase of activity was evident at six sites following a thaw on 12 February, with tracks leading from or to dens in four instances. Activity during mid-winter thaws was common during the study period, but evidently was mostly confined to males; of 13 road-killed skunks examined during December through February, 12 were males. Dean (1965) also noted the reactivation of winter-denned skunks during above-freezing temperatures.

Emergence of skunks from two ground burrows occurred in mid-February and mid-March 1972. The latter emergence occurred in an area of snow accumulation and the emerging skunk had to burrow through approximately 50 cm of snow to leave the den. Movements of skunks from dens were common by mid-March. Males appear to leave dens earlier than females. Two skunks captured away from dens at Tofield in March were males. Preponderance of male skunks in fur harvest records (see Verts 1967) are likely explainable by greater and earlier activities of male skunks during winter and spring as recorded here.

Dates of departure of six radio-collared adult female skunks from dens at Tofield were all between 2 and 9 April 1974. Because some of the six skunks may have denned before the 10 November snowfall (day 1), minimum period in winter dens during 1973–74, a winter of unusual severity, was 143 to 150 d. During the winter of 1971–72, a winter of moderate severity, most skunks were denned by mid-November and skunks in communes were mostly inactive until mid-March, a period of approximately 120 d.

These observations indicate that female skunks generally occupy winter dens in the parkland of Alberta between 120 and 150 d, and that males usually den for shorter periods. In Alberta the winter period is shorter in the prairie portion of the province and skunks in that area denned for correspondingly shorter periods. We observed numerous tracks leading from dens in southern areas of the province during March and male-female pairs of skunks were often observed at non-winter sites during that month. Skunks occupied winter dens 79–125 d in Minnesota (Sunquist 1974) and 62–87 d in Illinois (Verts 1967; Storm 1972).

Movements to and from Winter Dens

Juveniles travelled further than adults to winter dens; mean greatest distances from dens of 47 adult

and 22 juvenile skunks during summer were 2.3 and 3.1 km, respectively. Adults tended to occupy the same general areas during consecutive summers (Bjorge 1977). Four adult females, monitored by telemetry from 46 to 85 d after leaving the den in spring, travelled greatest straight-line distances of 1.6 to 3.4 km. Two other females, monitored from July and August travelled 3.0 and 3.5 km to their winter dens.

Movements of juvenile female skunks to winter dens were 13.7, 5.9, and 5.6 km from initial locations in July, September, and October, respectively. One other juvenile female travelled 21.7 km to a farmyard where she was shot before denning. Extensive dispersals of juveniles were recorded in another intensive study area in the prairie region in Alberta (P. Andersen, University of Calgary, personal communication). The observed mobility of juveniles may be related to a search for acceptance into a winter commune.

Concluding Discussion

Carnivores have evolved a wide range of species-specific winter denning strategies varying from the mostly solitary denning of bears to the highly communal denning of female Striped Skunks as reported here. Social organization of denning would appear to be importantly related to reproduction in carnivores. European Badgers (*Meles meles*) and American Badgers (*Taxidea taxus*) apparently den either in pairs or solitarily (Neal 1948; Ewer 1973; Lindzey 1978). Breeding of badgers and bears occurs during summer (see Ewer 1973), and is followed by delayed implantation; thus, communal denning in these species would not enhance reproduction. Because Striped Skunks breed during or immediately after winter denning, reproduction is potentially more successful where numbers of females are available to at least one male. Ewer (1973) noted that Verts observed one male would breed several captive female skunks in short order; such behavior would ensure that all females become pregnant. Pregnancy rates of Striped Skunks in Alberta were high during the study period (unpublished data).

Communal winter denning is common in Raccoons (*Procyon lotor*), although group size is usually small (Ewer 1973), despite one den of 23 individuals (Mech and Turkowski 1966). Family groups of Raccoons den together (Whitney and Underwood 1952). Our observations suggest that family groups of Striped Skunks in Alberta do not often den together. Genetic variation would be maintained by family separation in areas where a significant proportion of breeding occurs during winter denning.

In summary, communal denning appears to have adaptive value for winter survival and reproductive success of Striped Skunks, especially in more northern latitudes where the period of inactivity and fasting is longer, where energy conservation can be critical, and where breeding may be influenced by winter distribution.

Acknowledgments

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Range Extensions of Vascular Plants in Northern Yukon Territory and Northwestern District of Mackenzie

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Between 1970 and 1975 plant communities in the Yukon Territory and the District of Mackenzie north of 67°N were investigated. We record three taxa new to the known flora of the Yukon Territory and one new to the flora of the District of Mackenzie. Among the other vascular plants listed here, nine are new to the range predicted by Hultén within the Yukon Territory, 23 are extensions within predicted ranges and thus corroborate these predictions, and 29 are extensions beyond predicted ranges.

Key Words: vascular plants, Yukon Territory, District of Mackenzie, flora.

Between 1970 and 1975 over 800 collections of vascular plants, representing 220 species, 53 subspecies and seven varieties, were made during Canadian Wildlife Service studies in the northern Yukon Territory. Hultén (1968), Welsh and Rigby (1971), and Wein et al. (1974) have reported extensive collections and recent range extensions for vascular plants from our study area. We record here additional species to the reported flora of the Yukon Territory and northwestern District of Mackenzie. We also note species that occur outside of the ranges predicted by Hultén (1968), or were collected for the first time in northern Yukon Territory within ranges predicted. In addition, a number of species are recorded as the northernmost or southernmost collections within ranges from which collections are known.

The study area and collection locations are shown in Figure 1. The 31 collection sites from which plant specimens were obtained ranged in elevation from 122 to 152 m asl on the Arctic Coastal Plain, 244 to 427 m asl on the Old Crow Flats, and 152 to 1067 m asl in the Barn, British, and Richardson mountains. Bostock (1961) and Welsh and Rigby (1971) describe the physiography of the area.

Our activities were primarily concentrated in areas that had not received attention from previous investigators. Collectors were A. M. Pearson 1970, 1973, 1974, 1975; J. A. Nagy 1974, 1975; M. Dennington 1975; B. C. Goski 1973, 1974; D. Pearson 1974; C. B. Larsen 1973, 1974; J. W. Nolan 1973. The collections made during 1970 and 1973 were identified by A. E. Porsild, National Museum of Natural Sciences, Ottawa, and those collected during 1974 and 1975, by W. J. Cody and G. A. Mulligan (*Draba*), Biosystematics Research Institute, Canada Agriculture, Ottawa, Ontario.

Collection Sites

Approximate collection site locations are shown in Figure 1. Other site data are listed below.

1) Sam Lake, 68°25′N, 138°35′W, elevation ca. 427 m (1400 ft). Marshy polygonal; dry-to-wet tundra and hummocky lakeside areas; marshy and wet shrubby lakeside areas.
2) Canoe River, 68°37′N, 138°43′W, elevation ca. 305 m (1000 ft). Wet sedge meadows west of river.
3) Ridge 1.6 km east of Sam Lake, 68°24′N, 138°33′W, elevation ca. 488 m (1600 ft). Dry rocky and moist-to-wet tundra on ridge; dry south- and north-facing scree slopes; wet snow bed community near drainage.
4) Anker Creek, 68°43′N, 137°33′W, elevation ca. 122 m (400 ft). Alder-willow bluffs on moist-to-wet south-facing slope; dry rocky talus slope.
5) Trail River, 68°57′N, 138°56′W, elevation ca. 152 m (500 ft). South-facing river bank.
6) Headwaters of Anker Creek, 68°30′N, 138°19′W, elevation ca. 945 m (3100 ft). Alpine slope and tundra.
7) 6.4 km northwest of Sam Lake, 68°28′N, 138°40′W, elevation ca. 457 to 762 m (1500 to 2500 ft). Areas of dry, rocky and moist-to-wet tundra; moist-to-wet and swampy areas in and along edge of White Spruce (*Picea glauca*) stand; willows (*Salix* spp.) in and along edge of White Spruce stand; grassy slopes on upper edge of White Spruce stand; dry rocky ridge and slope.

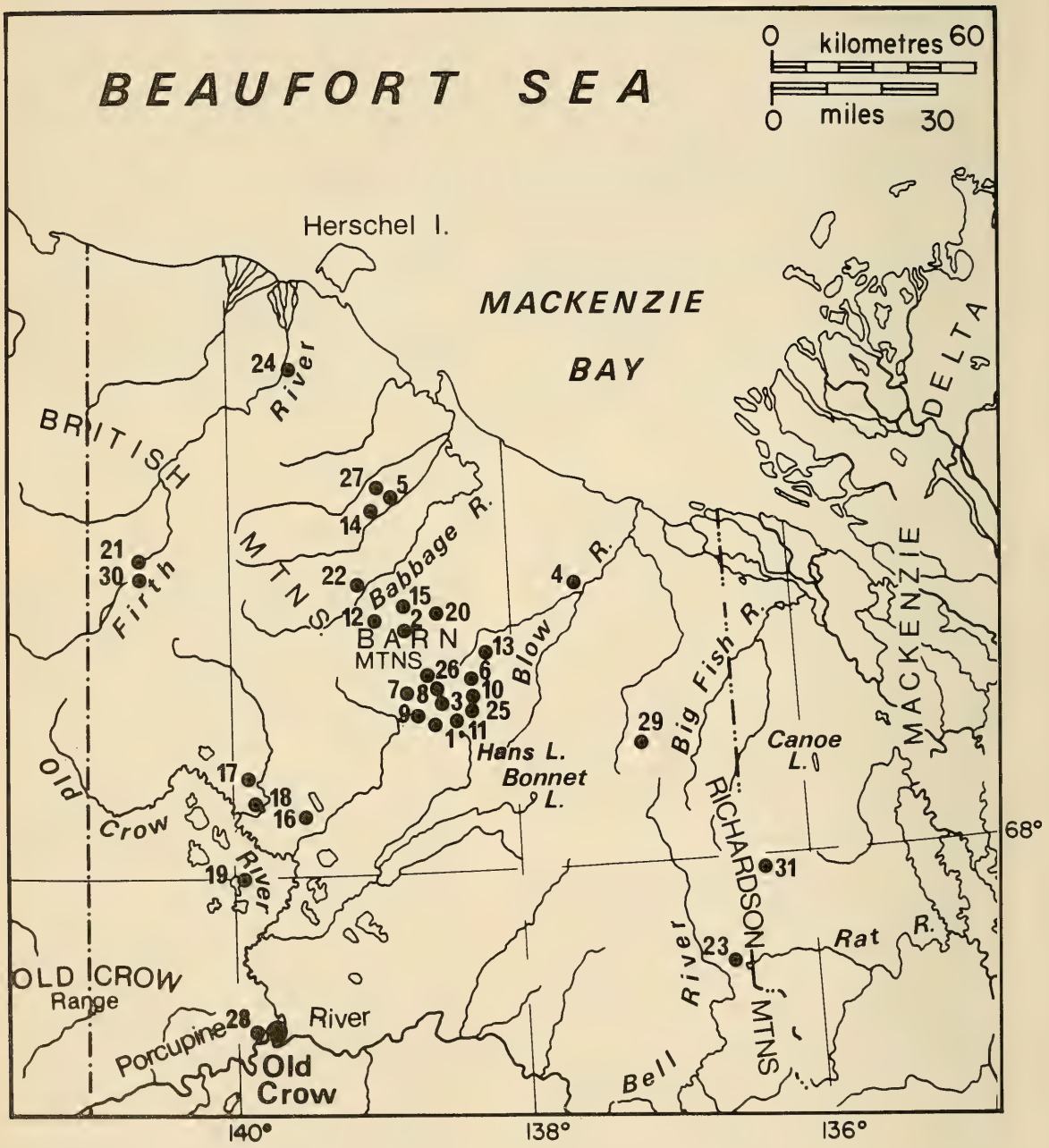

FIGURE 1. Locations of 31 vascular plant collection sites in the northern Yukon Territory and northwestern District of Mackenzie.

8) Ridge 1.6 km (1 mi) north of Sam Lake, 68°25′N, 138°35′W, elevation ca. 518 m (1700 ft). Dry rocky slopes.
9) Dog Creek, 68°25′N, 138°38′W, elevation ca. 427 m (1400 ft). Willows along drainage; and tundra.
10) Headwaters of Boulder Creek, 68°26′N, 138°13′W, elevation ca. 488 m (1600 ft). Moist-to-dry rocky south-facing slopes; stabilized south-facing talus slope; mossy wet stream bed; moist tundra along creek.
11) Ridge above Boulder Creek, 68°25′N, 138°16′W, elevation ca. 914 m (3000 ft). Dry rock south-facing slope.
12) Tributary of Babbage River, 68°38′N, 138°01′W, elevation ca. 427 m (1400 ft). Wet mossy stream bank; wet streamside willow stand; dry south-facing slope.
13) Tributary of Fitton Creek, 68°33′N, 138°10′W, elevation ca. 457 m (1500 ft). Moist drainage; dry rocky ridge.
14) Trail River, 68°58′N, 138°58′W, elevation ca. 396 m (1300 ft). Moist drainage; dry south-facing slope.
15) Spruce Creek, 68°56′N, 138°41′W, elevation ca. 305 m (1000 ft). White Spruce stand on dry south-facing slope.
16) Old Crow Flats, 68°09′N, 139°35′W, elevation ca. 274 m (900 ft). Bog.
17) Old Crow Flats, 68°12′N, 139°49′W, elevation ca. 305 m (1000 ft). White Spruce stand on dry ridge; marshy area.
18) Old Crow Flats, 68°12′N, 139°48′W, elevation ca. 305 m (1000 ft). Sphagnum bog.
19) Old Crow Flats, 68°01′N, 139°48′W, elevation ca. 244 m (800 ft). Sphagnum bog.
20) Headwaters of Babbage River, 68°38′N, 139°32′W, elevation ca. 457 m (1500 ft). Willows along stream bank; tundra.
21) Margaret Lake, 68°50′N, 140°36′W, elevation ca. 457 m (1500 ft). Tundra along Firth River.
22) Babbage Falls, 68°43′N, 139°03′W, elevation ca. 274 m (900 ft). Rock crevices along falls; dry rocky south-facing slope.
23) Bell River, 67°43′N, 136°33′W, elevation ca. 427 to 457 m (1400 to 1500 ft). Scree slope; White Spruce – White Birch (*Betula papyrifera*) – willow stand; sphagnum bog; moist slope.
24) Firth River, 69°20′N, 139°33′W, elevation ca. 152 m (500 ft). North-facing rock outcrop.
25) Boulder Creek, 68°25′N, 138°15′W, elevation ca. 457 m (1500 ft). Moist creek-side areas near headwaters.
26) Sam Lake, 68°30′N, 138°35′W, elevation ca. 762 m (2500 ft). Dry hilltop.
27) Mount Sedgwick, 68°58′N, 139°01′W, elevation ca. 305 m (1000 ft). Dry slope near ridge top; moist creek-side area.
28) Old Crow, 67°35′N, 139°50′W, elevation ca. 250 m (820 ft). Roadside near airstrip.
29) Rapid River, 68°16′N, 137°08′W, elevation ca. 914 m (3000 ft). Sedge association in thick organic soil on moist south-facing rock slide.
30) Margaret Lake, 68°48′N, 140°36′W, elevation ca. 457 m (1500 ft). Lakeside sphagnum bog.
31) Bear Creek, 67°58′N, 136°12′W, elevation ca. 1067 m (3500 ft). Moist basin.

Vascular Plant Range Extensions

The 65 taxa reported here are listed with collection sites, habitats, collection years, and collection numbers. Nomenclature follows Hultén (1968) and if names used by Porsild and Cody (1968) differ, they are also given, in parentheses. A complete set of voucher specimens has been deposited in the Canadian Wildlife Service Herbarium at Edmonton, with duplicates of the 1974 collections deposited at the Canada Agriculture Herbarium in Ottawa (DAO).

Three taxa, *Luzula Wahlenbergii* ssp. *Wahlenbergii*, *Potentilla rubricaulis*, and *Galium Brandegei* are reported as new to the flora of the Yukon Territory, and one species, *Cerastium maximum*, as new to the flora of the Continental Northwest Territories.

The new range data provided here on the taxa listed represents a contribution to our knowledge of the phytogeography of these taxa, as well as a contribution towards a flora of Yukon Territory.

Lycopodiaceae

Lycopodium annotinum ssp. *pungens* (Stiff Club-moss). Site 1: shrubby lakeshore, *74-58*; site 4; alder, *74-189*; site 5: river bank, *74-10*; site 23: sphagnum bog, *74-683*. Helps complete gaps in the predicted distribution between sites in northwestern District of Mackenzie and Alaska, extending the known range northward to the Arctic Coastal Plain (Hultén 1968).

Lycopodium complanatum (Ground-Cedar). Site 23: mixed White Spruce – birch – willow, *74-681*. Extends the known range northward from collection localities reported by Hultén (1968) and Wein et al. (1974) along the Yukon River drainage.

Polypodiaceae

Cystopteris fragilis ssp. *fragilis* (Fragile Fern). Site 22: crevices along falls, *74-675*. Hultén (1968) predicted the occurrence of both ssp. *fragilis* and ssp. *Dickieana* in northern Yukon Territory and did plot one collection from Yukon Territory north of 65°N, along the Yukon River drainage near the Alaska border. Welsh and Rigby (1971) reported three specimens from the British Mountains, but did not give their collections a subspecific designation. The specimen reported here is the first record of ssp. *fragilis*

within the predicted range for northern Yukon Territory (Hultén 1968).

Dryopteris fragrans (Fragrant Cliff-Fern). Site 5: river bank, *74-13*; site 14: south-facing slope, *74-435*. Welsh and Rigby (1971) reported the first collection from the northern Yukon Territory. The specimens reported here are the most northern collections, and help complete gaps in the predicted distribution for northern Yukon Territory (Hultén 1968).

Sparganiaceae

Sparganium minimum (Bur-reed). Site 18: emergent aquatic, *74-556*. Extends the known range significantly northward from collection localities in west central Yukon Territory to the Old Crow Flats (Hultén 1968).

Potamogetonaceae

Potamogeton alpinus ssp. *tenuifolius*. Site 18: sphagnum bog, *74-550*. Extends the known range to the northwest of Welsh and Rigby's (1971) recent first collection for Yukon Territory north of 65°N.

Potamogeton perfoliatus ssp. *Richardsonii* (*P. Richardsonii*) (Red-head Pondweed). Site 16: submerged aquatic, *74-511*. First record from the predicted range for the Yukon Territory north of 65°N (Hultén 1968). Helps bridge the gap in the distribution between collection sites in Alaska and northwestern District of Mackenzie.

Gramineae

Calamagrostis canadensis ssp. *Lansdorffii* (Blue-joint). Site 18: sphagnum bog, *74-549*; site 25: creek bank, *73-1*, *73-3*. Hultén (1968) predicted the occurrence of both ssp. *canadensis* and ssp. *Langsdorffii* in northern Yukon and reported collections of both subspecies adjacent to the Yukon Territory border. Welsh and Rigby (1971) reported a specimen of *C. canadensis* from the Old Crow Flats, but did not give their collection a subspecific designation. This is the first report of ssp. *Langsdorffii* from the predicted range for Yukon Territory north of 65°N.

Calamagrostis purpurascens. Site 21: tundra, *74-667*. Hultén (1968) cited collections from adjacent areas in Alaska and northwestern District of Mackenzie, while Welsh and Rigby (1971) reported the first collections from northern Yukon Territory. The specimen reported here is the most northern collection within the predicted range for Yukon Territory (Hultén 1968).

Festuca ovina ssp. *alaskana*. Site 8: dry rocky ridge, *74-320*. Hultén (1968) reported a collection from the Yukon River drainage near the District of Mackenzie border, and Cody has collected it in the Richardson Mountains to the east in District of Mackenzie (Cody and Porsild 1968). The specimen reported here is the most northern collection in the predicted range in Yukon Territory.

Cyperaceae

Carex glacialis. Site 7: rocky south-facing slope, *74-254*. First record within the predicted range for Yukon Territory north of 65°N (Hultén 1968).

Carex lapponica (*C. canescens* var. *subloliacea*). Site 19: sphagnum bog, *74-560*. Extends the known range significantly northward from central Yukon Territory to the Old Crow Flats (Hultén 1968).

Carex membranacea. Site 6: alpine tundra, *74-346*; Site 7: White Spruce stand, *74-615*; site 7: dry rocky ridge, *74-288*; site 20: tundra, *74-586a*. Hultén (1968) plotted collection localities from adjacent areas in Alaska and District of Mackenzie. The specimens reported here are the first collections from the predicted range for Yukon Territory north of 65°N.

Carex Williamsii. Site 16: bog, *74-508*. First reported for northern Yukon but is from south of the range predicted by Hultén (1968) for the northern Yukon Territory, and represents only the fourth collection for Yukon Territory (Porsild 1975).

Eriophorum angustifolium ssp. *triste* (*E. triste*). Site 6: alpine tundra, *74-347*; site 7: dry rocky ridge, *74-118*. Hultén (1968) indicated a collection from the Firth River drainage in Alaska near the Alaska border. The specimens reported here are the first collections from the predicted range for Yukon Territory north of 65°.

Eriophorum russeolum var. *albidum*. Site 1: marsh, *74-75*. Hultén (1968) cited collection sites from adjacent areas in Alaska and northwestern District of Mackenzie. The specimen reported here is the first collection from the range predicted by Hultén (1968) for northern Yukon Territory. Porsild (1951, 1975) has reported it from along the Canol Road and the Ogilvie Mountains.

Araceae

Calla palustris (Wild Calla). Site 18: sphagnum bog, *74-546;* site 28: roadside, *73-8*. Hultén (1968) reported a collection from the headwaters of the Yukon River. Our collection extends the known range northwestward to the Old Crow Flats.

Lemnaceae

Lemna trisulca (Star-Duckweed). Site 18: floating aquatic in sphagnum bog, *74-554*. Northernmost collection within the range predicted by Hultén (1968) for Yukon Territory.

Juncaceae

Juncus articus ssp. *alaskanus* (*J. balticus* var. *alaskanus*). Site 21: riverside tundra, *74-664*. Welsh and Rigby (1971) reported the first collection (presumably var. *alaskanus*) of *J. arcticus* from northern Yukon Territory, but did not give their specimen a subspecific designation. This is thus only the second record of ssp. *alaskanus* within the range predicted by Hultén (1968) for Yukon Territory north of 65°N.

Luzula arctica (*L. nivalis*). Site 10: south-facing slope, *74-170*. First report from the predicted range for Yukon Territory north of 65°N (Hultén 1968) and helps bridge the gap between collection localities in Alaska and northwestern District of Mackenzie.

Luzula arcuata s. lat. Site 13: drainage, *74-383*. First collection from Yukon Territory north of 65°N, and is from near the northern limit as predicted by Hultén (1968).

Luzula multiflora s. lat. Site 3: dry rocky hillside, *74-633*; site 7: tundra, *74-241*. First collections within the range predicted by Hultén (1968) for Yukon Territory north of 65°N.

Luzula parviflora. Site 12: stream bank, *74-212*. First collection from Yukon Territory north of 66°N, extending the known range northward to the Barn Mountains (Hultén 1968).

Luzula Wahlenbergii ssp. *Wahlenbergii*. Site 1: polygonal ground, *74-269*. Hultén (1968) reported a collection from northwestern District of Mackenzie adjacent to the Yukon Territory border. The specimen reported here is the first collection from the range predicted by Hultén (1968) for Yukon Territory and is new to the Territory.

Orchidaceae

Spiranthes Romanzoffiana (Hooded Ladies'-Tresses). Site 7: bog, *74-503;* sphagnum bog, *74-561*. First collection reported from Yukon Territory north of 65° N, extending the predicted range westward from collection localities in northwestern District of Mackenzie to northern Yukon Territory (Hultén 1968).

Salicaceae

Salix Barrattiana. Site 14: drainage, *74-463*. First specimen collected in northern Yukon Territory, extending the predicted range eastward from collection sites in Alaska (Hultén 1968).

Caryophyllaceae

Cerastium maximum. Site 31: alpine basin, *73-46*. Wein et al. (1964) extended the range of *C. maximum* eastward to the headwaters of the Yukon River from near the Alaska border (Hultén 1968). The collection reported here extends the range further eastward to the Richardson Mountains of northwestern District of Mackenzie. This species is thus new to the flora of Continental Northwest Territories (Porsild and Cody 1968).

Silene acaulis ssp. *subacaulescens* (Moss Campion). Site 7: alpine tundra, *74-341*; site 30: sphagnum bog, *73-5*. Hultén (1968) plotted a collection locality along the Firth River drainage near the Alaskan border. The specimens reported here are the first collections from the predicted range for Yukon Territory north of 65° N (Hultén 1968).

Ranunculaceae

Anemone narcissiflora s. lat. Site 29: sedges on rock slide, *73-1*. Hultén (1968) indicates several collection sites of *A. narcissiflora* ssp. *interior* from the District of Mackenzie adjacent to the Yukon Territory border. Our collection is the first report from the predicted range for Yukon Territory north of 65° N.

Ranunculus Eschscholtzii. Site 25: creek bank, *73-9*. Hultén (1968) reported a collection from District of Mackenzie adjacent to Yukon Territory. The specimen reported here is the first collection from Yukon Territory north of 65° N, extending the known range westward from northwestern District of Mackenzie to the Barn Mountains.

Papaveraceae

Papaver Hultenii. Site 24: rock outcrop, *75-1*. First collection within the predicted range for northern Yukon Territory (Hultén 1968).

Papaver Macounii (*P. Keelei*). Site 7: White Spruce stand, *74-618*; site 10: south-facing slope, *74-161*; site 27: creek bank, *70-22*; site 30: sphagnum bog, *73-4*. Hultén (1968) indicated collection localities from adjacent areas in Alaska and northwestern District of Mackenzie. These are the first specimens collected in the predicted range for Yukon Territory north of 65° N (Hultén 1968).

Cruciferae

Cardamine umbellata. Site 1: lakeshore, *74-641*. First collection from Yukon Territory north of 65° N, extending the known range significantly northward to the Barn Mountains (Hultén 1968).

Draba alpina. Site 7: dry rocky ridge, *74-100*. Welsh and Rigby (1971) reported a collection from the Firth River drainage, within the range predicted by Hultén (1968). Our collection extends the known range southeastward from this station.

Draba borealis. Site 24: rock outcrop, *75-4*. Hultén (1968) plotted an isolated collection in southwestern Yukon Territory from about 137° W. A more recent map is given by Mulligan (1970). The specimen reported here is the first collection from northern Yukon Territory, and extends its known range significantly northward from about 63° N.

Draba crassifolia. Site 24: rock outcrop, *75-9*. Hultén (1968) reported an isolated collection from the Mackenzie River drainage adjacent to northern Yukon Territory. A more recent map is given by Mulligan (1975). The specimen reported here is the first collection from Yukon Territory north of 65° N, extending the known range westward.

Draba incerta. Site 7: dry rocky ridge, *74-98*; site 10: south-facing slope, *74-158*, *74-164*; site 13: dry rocky ridge, *74-404*. Hultén (1968) plotted three collections from southern Yukon Territory in close proximity to the British Columbia border. A more extensive map is given by Mulligan (1972). The collections reported here extend the known range significantly northward to northern Yukon Territory.

Droseraceae

Drosera rotundifolia (Round-leaved Sundew). Site 18: sphagnum bog, *74-543*. Hultén (1968) reported an isolated collection from the Mackenzie River drainage. Our specimen is the first collection from Yukon Territory north of 65° N, extending the known range northward to the Old Crow Flats.

Saxifragaceae

Saxifraga caespitosa (Tufted Saxifrage). Site 11: dry rocky ridge, *74-183*. Extends the known range southeastward from the recent first collections reported from northern Yukon Territory by Welsh and Rigby (1971) and Wein et al. (1974).

Saxifraga hieracifolia. Site 21: tundra, *74-587*. Hultén (1968) and Wein et al. (1974) reported collections from localities along north coastal Yukon Territory. The collection reported here extends the known range slightly southward along the Firth River drainage.

Ribes triste (Red Currant). Site 4: alder stand on river bank, *74-190*. Previously reported from the Old Crow Flats and northwestern District of Mackenzie by Hultén (1968). The specimen reported here extends the known range northward to the arctic coastal plain.

Rosaceae

Dryas octopetala L. ssp. *alaskensis* (*D. alaskensis*). Site 7: White Spruce stand, *74-82;* site 27: dry ridge, *70-22*. Wein et al. (1974) reported the first collection of this species for northern Yukon Territory from the headwaters of the Yukon River drainage. The collections reported here extend the

known range northward and bridge the gap between collection localities in Alaska and northwestern District of Mackenzie (Hultén 1968).

Potentilla elegans. Site 3: dry rocky slope, *74-36;* site 6: alpine tundra, *74-350;* site 11: dry rocky ridge, *74-179;* site 13: drainage, *74-377*. Extends the known range eastward from the recent extensions reported by Welsh and Rigby (1971) and Wein et al. (1974).

Potentilla hyparctica. Site 11: dry rocky ridge, *74-184;* site 14: south-facing slope, *74-453*. First collections reported for Yukon Territory north of 65° N, extending the known range eastward from localities in Alaska (Hultén 1968).

Potentilla Hookeriana ssp. *Hookeriana* (*P. nivea* ssp. *Hookeriana*). Site 22: rock crevices, *74-671*. Hultén (1968) reported collections of *P. Hookeriana* from coastal northern Yukon Territory and the Old Crow Flats. The collection reported here extends the known distribution southeastward within the predicted range (Hultén 1968).

Potentilla rubricaulis. Site 3: dry rocky ridge, *74-24, 74-237;* site 7: dry rocky ridge, *74-103, 74-114, 74-257, 74-289,* alpine tundra, *74-334;* site 8: dry rocky slope, *74-70;* site 10: south-facing slope, *74-154, 74-168*. First collections from Yukon Territory, expanding the known range westward from northwestern District of Mackenzie (Hultén 1968).

Rubus arcticus ssp. *acaulis* (*R. acaulis*). Site 16: bog, *74-504*. Hultén (1968) reported collections from adjacent areas in Alaska and northwestern District of Mackenzie. The specimen reported here is the first collection from the predicted range for Yukon Territory north of 65° N (Hultén 1968).

Sibbaldia procumbens. Site 6: alpine tundra, *74-360*. Hultén (1968) reported an isolated collection from northwestern District of Mackenzie. The specimen reported here is the first collection from Yukon Territory north of 65° N, and extends the known range westward to the Barn Mountains from the Richardson Mountains in northwestern District of Mackenzie.

Leguminosae

Oxytropis borealis (*O. glutinosa*). Site 24: rock outcrop, *75-18*. First report from the range predicted for northern Yukon Territory, and helps bridge the gap in its distribution between localities in northwestern District of Mackenzie and Alaska (Hultén 1968).

Oxytropis deflexa var. *sericea*. Site 16: bog, *74-496*. First collection from Yukon Territory north of 65° N, extending the known range northward to the Old Crow Flats (Hultén 1968).

Oxytropis nigrescens ssp. *pygmaea* (*O. pygmaea*). Site 7: dry rocky ridge, *74-55, 74-109;* site 11: dry rocky slope, *74-174;* site 26: dry hilltop, *70-20h;* site 29: sedge association on rock slide, *73-0*. Hultén (1968) reported several collections from the Alaskan coast adjacent to the Yukon Territory border. The collections reported here extend the known range across northern Yukon Territory.

Pyrolaceae

Moneses uniflora (One-flowered Pyrola). Site 7: White Spruce stand, *74-605*. Hultén (1968) plotted a collection site along the Yukon River drainage near the Alaska border. Our collection extends the known range northward to the Barn Mountains.

Pyrola secunda ssp. *obtusata* (One-sided Pyrola). Site 7: White Spruce stand, *74-617;* site 16: bog, *74-493;* site 17: White Spruce stand, *74-525*. Hultén (1968) indicated a collection site from the Firth River drainage along the Alaska border. The specimens reported here are the first collections from the predicted range for northern Yukon Territory.

Ericaceae

Chamaedaphne calyculata (Leather-leaf). Site 19: sphagnum bog, *74-562*. Hultén (1968) plotted a collection site along the Yukon River drainage near the Alaska border. The collection reported here extends the known range northward, well onto the Old Crow Flats.

Ledum palustre ssp. *groenlandicum* (*L. groenlandicum*) (Labrador-tea). Site 15: White Spruce stand, *74-474*. Hultén (1968) reported a collection from the Yukon River drainage near the village of Old Crow. Our collection extends the known range northward to the Barn Mountains.

Boraginaceae

Eritrichium splendens. Site 7: dry rocky ridge, *74-261, 74-306*. Hultén (1968) and Wein et al. (1974) reported specimens from the Yukon River drainage near the Alaska and District of Mackenzie borders, respectively. The collections cited here extend the known range northward to the Barn Mountains in northern Yukon Territory.

Scrophulariaceae

Pedicularis lapponica. Site 1: tundra, *74-199, 74-234;* site 9: tundra, *74-222;* site 26: dry hilltop, *70-20L*. Hultén (1968) reported a collection from the Old Crow Flats in northern Yukon Territory. The collections reported here extend the known distribution northward to the Barn Mountains, but still fall within the predicted range (Hultén 1968).

Lentibulariaceae

Pinguicula villosa. Site 1: polygonal ground, *74-268;* site 18: sphagnum bog, *74-552;* site 26: dry ridge, *70-20m*. Most northern collections within the range predicted by Hultén (1968). He had plotted a collection site on the Yukon River drainage near the southern edge of the Old Crow Flats.

Utricularia vulgaris (Bladderwort). Site 18: submerged aquatic, *74-555*. First collection from the predicted range for Yukon Territory north of 65° N (Hultén 1968).

Rubiaceae

Galium Brandegei. Site 19: sphagnum bog, *74-558*. First collection from the predicted range for the Yukon Territory and is new to the Territory. Helps bridge the gap in the distribution between collection localities in Alaska and northwestern District of Mackenzie (Hultén 1968).

Caprifoliaceae

Linnaea borealis ssp. *americana* (Twinflower). Site 3: dry rocky slope, *74-630*. first collection from its predicted range for Yukon Territory north of 65° N.

Compositae

Aster alpinus ssp. *Vierhapperi.* Site 3: dry rocky ridge, *74-283;* site 7: dry rocky ridge, *74-260, 74-272, 74-293.* Wein et al. (1974) reported a recent range extension from the Yukon River drainage in northern Yukon Territory adjacent to the District of Mackenzie border. The collections reported here extend the known range northward to the Barn Mountains.

Antennaria Friesiana ssp. *compacta* (*A. neoalaskana*). Site 3: dry rocky ridge, *74-239;* site 7: dry rocky ridge, *74-113;* site 8: dry rocky ridge, *74-311b;* site 10: south slope, *74-144;* site 13: dry rocky ridge, *74-405, 74-419.* Hultén (1968) reported a collection from the Old Crow Flats. The specimens reported here are the northernmost collections within the range predicted by Hultén (1968) for northern Yukon Territory.

Senecio atropurpureus ssp. *tomentosus* (Kjellm.) Hult. (*S. Kjellmannii*). Site 11: dry rocky ridge, *74-186.* First known collection from its predicted range in Yukon Territory north of 65°N, and helps bridge the gap in the distribution between collection localities in Alaska and District of Mackenzie.

Taraxacum phymatocarpum. Site 7: rocky alpine tundra, *74-105, 74-325, 74-338.* Hultén (1968) reported a collection from Herschel Island. These collections extend the known distribution within the predicted range, southward to the Barn Mountains.

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Food and Feeding of the Rainbow Smelt (*Osmerus mordax*) in Lake Simcoe, Ontario

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Feeding by adult Rainbow Smelt (*Osmerus mordax*) is selective and varies with fish size, sex, and season. Intensity of feeding is lowered prior to spawning. Zooplankton is the major food, and we found no evidence of predation on the eggs or young of sport fishes. Fish were found in the stomachs of 11% of the females and 4.3% of the males and were mainly young-of-the-year smelt in summer and lake Emerald Shiners (*Notropis atherinoides*) in winter and spring. Fish were eaten only by smelt of age groups I to V (156 to 204 mm in fork length) while crustaceans were the principal food of young-of-the-year smelt.

Key Words: seasonal variation, selection, food preference, diet, predation, food organisms, *Osmerus mordax*, limiting factors, body size, feeding behavior.

With the exception of a few lakes in the eastern part of the province (Dymond 1944), the invasion of Rainbow Smelt, *Osmerus mordax*, into Ontario inland waters is of recent origin. Smelt first appeared in Lake Simcoe (44°23′N, 79°18′W) in 1962, presumably as a result of an unrecorded release about 1960; a substantial naturalized smelt population resulted (MacCrimmon and Skobe 1970).

Because of a decline in Lake Trout (*Salvelinus namaycush*) and Whitefish (*Coregonus clupeaformis*) fisheries concurrent with the naturalization of smelt in Lake Simcoe, and because of the smelt's unique dentition (McAllister 1963), it is a popular accusation that the smelt is a serious predator on the eggs and young of commercial and sport fishes. This assumption is strengthened by the fact that Lake Simcoe smelt can be readily caught by anglers using hooks baited with fresh or salted Emerald Shiners, *Notropis atherinoides*, especially in the winter ice fishery. Studies elsewhere, however, have not confirmed that the smelt is an important predator on fishes (Creaser 1925, 1928; Kendall 1927; Greene 1930; Schneberger 1936; Gordon 1961; Ferguson 1965; Rupp 1968; Burbidge 1969; Delisle 1969; Lackey 1969; Anderson and Smith 1971; Selgeby et al. 1978).

We examined the stomach contents of smelt taken monthly by gill nets set in the lake and of mature adults collected from a river spawning area. Seasonal patterns of food and feeding of smelt in Lake Simcoe are reported, and the importance of predation on fishes assessed.

Materials and Methods

The area of intensive study included a 54-km^2 section of Lake Simcoe north of Sibbald Park, extending west from Georgina Island to Jackson's Point and then north to the 22-m depth contour. Monthly samples were taken from this area between August 1970 and August 1971 by means of gill nets set in the late morning for periods not exceeding 1 h. Specimens were chilled and examined in the laboratory within 3 h of capture. An additional sample of 336 smelt was collected from the 1971 spawning run in the nearby Pefferlaw River and frozen for later study. The data from fish stomachs taken during the spawning period are dealt with separately from those of other months.

Stomach contents were examined under a binocular microscope at 16X using a technique similar to that of Thompson (1959), Ferguson (1965), and Burbidge (1969). The volume of partially digested food was estimated as a percentage of its contribution to the total stomach food volume. The amounts of the individual food items in the remaining volume were expressed as percentage contribution to the total volume of undigested recognizable food items. The frequency of occurrence of specific food items is expressed as a percentage of those stomachs containing recognizable items. Stomachs containing only chyme or fluid were considered to be empty.

Results

Examination of the stomachs of 1416 adult smelt from Lake Simcoe between August 1970 and 1971 found that 76% contained food and, of these, recognizable items were present in 91.5% (Table 1). Feeding varied seasonally, both in kind and quantity of food eaten. All smelt stomachs collected in early June contained food, as did over 84% of those collected in July to December. Food intake was minimal in March and April before the spawning period but increased during and after spawning among mature fish captured during the Pefferlaw River spawning run. Females resumed feeding more quickly than males after spawning. Stomach fullness normally fluctuated between 47 and 69% of stomach

Table 1—Monthly stomach contents of mature Rainbow Smelt showing the number containing food, fullness, and the occurrences of recognizable food, all expressed in percentages

Month	Sample size		Stomachs containing food		Stomach fullness by volume		Stomachs containing recognizable food items	
	♂	♀	♂	♀	♂	♀	♂	♀
Aug.	22	89	100.0	98.1	50.9	46.7	90.9	92.1
Sept.	18	29	100.0	96.6	51.7	55.9	50.0	57.1
Oct.	37	68	100.0	100.0	52.7	50.9	89.2	77.9
Nov.	1	36	—	86.1	—	68.6	—	96.8
Dec.	22	78	100.0	98.7	57.3	60.0	100.0	98.7
Jan.	72	60	100.0	100.0	57.9	62.6	94.4	98.3
Feb.	48	60	72.9	71.7	36.3	44.9	97.1	88.4
Mar.	54	61	16.7	21.3	55.0	46.5	100.0	100.0
Apr.*	163	62	22.7	38.7	10.3	11.3	100.0	100.0
May	28	68	64.3	82.4	58.1	68.5	100.0	100.0
June	46	58	100.0	100.0	64.0	67.6	87.0	89.7
July	29	83	86.2	86.8	65.2	48.7	92.0	87.5
Aug.	41	83	97.6	92.8	70.3	59.0	97.5	96.1
By sex								
Number	581	835	381	695	381	695	349	635
Mean			65.6	83.2	52.5	55.0	91.6	91.4
Combined (♂+♀)								
Number	1416		1076		1076		984	
Mean			76.0		54.0		91.5	
Mature fish on Pefferlaw River spawning grounds	336		42.0		45.9		100.0	

*Excludes spawning fish.

capacity, but the food volume in April was only 10%. Although stomach fullness varied slightly (1.0–16.5%) between males and females in any one monthly sampling period, the yearly average was nearly the same (Table 1).

The importance of each food item varied with season and both sexes typically ate the most abundant and/or largest organisms available. In winter (January to March) copepods (*Cyclops* sp. and *Diaptomus oregonensis*) were the most important food items eaten by both sexes, followed by cladocerans (mainly *Bosmina* sp.) which became prevalent in February. Amphipods (*Gammarus*) and fish (*N. atherinoides*, and young-of-the-year *O. mordax*) made up 28 and 40% respectively, of the food in February and March. In April, prior to spawning, copepods and tendipedids were the most frequent organisms eaten (Table 2).

In smelt captured during the spawning run in the Pefferlaw River, fish eggs (*O. mordax* and *Catostomus commersoni*) accounted for 55.7% of the food volume in those stomachs containing food. No extraneous matter was found in the eggs. Emerald Shiners were found in 31% of these fish, and made up 30% of the total volume of food consumed in the spawning and post-spawning period. The remaining volume of recognizable food items consisted of unidentified fish larvae (2.8%), *Gammarus* (0.7%), and algae (0.7%). Empty stomachs were found in 58% of fish collected and many of these were enlarged and contained only clear fluid.

Smelt collected in the lake in May and June had fed principally on the dipteran larvae of *Chaoborus albipes, Tendipes tentans, Pentaneuris monilis,* and the ephemeropteran nymph of *Hexagenia* sp. No bottom detritus was present in stomachs containing these benthic organisms. In July, cladocerans (*Leptodora kindtii*), tendipedidae pupae, and copepods were the dominant food items. In September to December, fish (mostly preserved Emerald Shiners used to prebait Whitefish fishing grounds) and cladocerans (*Bosmina* sp. and *Daphnia longispina*) made up a greater proportion of the food than did copepods (Table 2).

Although the seasonal variation in food items eaten was similar in both male and female smelt, slight differences in stomach volume and frequency of occurrence of these items did occur. Male smelt ate

TABLE 2—Monthly stomach contents of male and female Rainbow Smelt expressed by percent volume and by frequency (in parenthesis) of occurrence

Month	Food item						
	Cladocera	Copepoda	Tendipedidae	Fish	*Chaoborus*	*Hexagenia*	*Gammarus*
Aug.	53.6	4.6	32.0	6.0	3.0	—	—
	(88.1)	(82.2)	(47.5)	(6.9)	(3.0)	—	—
Sept.	49.6	18.9	13.6	17.1	—	0.4	—
	(75.0)	(78.6)	(42.9)	(21.4)	—	(3.6)	
Oct.	49.1	5.8	6.8	34.1	—	—	3.0
	(65.1)	(58.1)	(12.8)	(37.2)	—	—	(5.8)
Nov.	76.0	6.0	0.7	11.0	—	—	6.3
	(100.0)	(100.0)	(6.7)	(16.7)	—	—	(16.7)
Dec.	92.1	7.5	—	—	—	—	0.4
	(100.0)	(100.0)	—	—	—	—	(1.0)
Jan.	5.4	82.9	0.3	7.1	0.2	—	0.9
	(80.3)	(92.1)	(3.1)	(7.1)	(2.4)	—	(7.9)
Feb.	36.0	30.7	0.3	11.0	5.1	—	16.8
	(70.8)	(79.2)	(1.4)	(12.5)	(6.9)	—	(19.4)
Mar.	0.5	55.0	—	26.1	3.2	—	14.1
	(4.5)	(59.1)	—	(36.4)	(4.5)	—	(18.2)
Apr.	—	69.9	14.2	1.7	—	—	3.3
	—	(71.1)	(21.3)	(1.6)	—	—	(4.9)
May	—	8.5	46.5	4.4	9.3	24.3	4.3
		(25.0)	(67.7)	(4.4)	(27.9)	(30.9)	(5.9)
June	2.0	19.7	52.0	—	2.1	28.0	—
	(12.0)	(25.0)	(53.3)	—	(6.4)	(38.0)	—
July	46.5	9.4	13.7	2.1	21.5	6.9	—
	(83.7)	(45.3)	(43.0)	(2.3)	(46.5)	(8.1)	
Aug.	80.3	2.2	11.0	2.5	3.8	—	—
	(91.2)	(30.1)	(31.9)	(2.7)	(16.8)	—	—
Mean, sexes combined	39.5	23.9	15.8	7.6	3.9	4.9	2.6
	(64.4)	(64.0)	(26.3)	(8.6)	(9.6)	(3.0)	(3.6)
Mean, by sex							
♂	36.0	35.9	14.2	3.5	2.1	4.8	2.8
	(66.2)	(70.5)	(27.0)	(4.3)	(8.0)	(1.2)	(3.4)
♀	41.5	17.3	16.6	9.9	4.9	5.0	2.4
	(63.5)	(60.5)	(26.0)	(11.0)	(10.7)	(5.4)	(3.9)

cladocerans and copepods in equal quantities (36% by volume), supplemented by tendipedidae (14.2%) and, to a lesser extent, by *Hexagenia*, fish, *Gammarus*, and *Chaoborus*, respectively. Females fed primarily on cladocerans (41.5%), followed, in decreasing amounts, by copepods, tendipedidae, fish, *Chaoborus*, *Hexagenia*, and *Gammarus* (Table 2).

Larger smelt exhibited a more varied diet than did smaller fish (Table 3). The occurrence of tendipedidae (larvae and pupae), *Chaoborus*, *Hexagenia*, and fish (Emerald Shiners and young-of-the-year Rainbow Smelt) each increased with fish length. Fish first appeared in the diet of smelt at Age Group 1.

Most of the identifiable fish eaten throughout the year were young-of-the-year smelt. During the autumn and winter months, preserved (salted) Emerald Shiners, which are used as bait and for prebaiting Whitefish fishing grounds, were eaten occasionally. In the spring (mostly after the smelt had spawned), live shiners were consumed in substantial quantities (30.8% by volume in the river sample). The high percentage of Emerald Shiners occurring in the October sample (34% by volume) resulted from a collection of smelt made in proximity to an area newly baited for Whitefish. The only other fish found in smelt stomachs were two larval White Suckers (*C. commersoni*) (15 mm in length) and a single small darter (*Etheostoma* sp.).

Discussion

As a result of the broad temperature regime favorable for smelt feeding and growth (Ferguson 1965), the smelt is able to feed throughout the year and at various water depths on a variety of food

Table 3—Percent annual frequency of occurrence of major food items eaten by adult Rainbow Smelt (130 to 209 mm fork length) excluding fish taken during spawning season

Length interval (mm)	No. of fish	Fish empty	Total remains	Stomachs containing recognizable food items	Food item					
					Cladocera	Copepoda	Tendipedidae	*Chaoborus*	*Hexagenia*	Fish	*Gammarus*
130–139	1	—	—	1	100.0	100.0	—	—	—	—	—
140–149	10	—	—	10	100.0	90.0	—	—	—		10.0
150–159	46		7	39	97.4	89.7	12.8	7.7	—	—	—
160–169	137	3	12	122	92.6	65.6	17.2	8.2	1.6	4.1	—
170–179	104	5	12	87	93.1	54.0	26.4	18.4	1.1	10.3	1.1
180–189	48	3	3	42	83.3	45.2	28.6	19.0	—	14.3	4.8
190–199	24	2	7	15	80.0	33.3	40.0	26.7	13.3	26.7	6.7
200–209	9	3	2	4	75.0	25.0	50.0	25.0	50.0		
Total	379	16	43	320							

organisms, especially zooplankton supplemented seasonally by small fish and benthic invertebrates. Similar items of diet are commonly used by smelt in the Great Lakes (Kendall 1927; Schneberger 1936; Baldwin 1948; Hale 1960; Gordon 1961; Anderson and Smith 1971) and in other inland waters (Greene 1930; Reif and Tappa 1966; Rupp 1968; Burbidge 1969; Delisle 1969; Lackey 1969). The diet of landlocked Arctic Smelt (*O. mordax dentex*) in the Rybinsk reservoir in Russia (Inanova et al. 1970) also resembles that of freshwater Rainbow Smelt in Lake Simcoe.

A comparison of the stomach contents of male and female fish indicates that although the food items are similar, the females eat more of the larger organisms (fish and dipteran larvae) and have a more varied diet. Also, recently spent males are slower to resume feeding than are females. There is no mention of these phenomena elsewhere in the published literature.

The absence of debris in smelt stomachs that contain eggs in the spring months, and benthic larvae and pupae at most times, indicates that feeding is selective in Lake Simcoe. Adult smelt generally select the largest organisms available and the larger fish have a more complex diet than the smaller fish. Similar feeding behavior was observed among smelt in lakes Superior (Hale 1960), Huron (Baldwin 1948), Champlain (Green 1930), and Gull Lake, Michigan (Burbidge 1969).

Lake Simcoe smelt feed extensively on eggs and fish during the spawning and post-spawning season in the rivers. Although over half the volume of food consumed at those times was comprised of smelt and sucker eggs, eggs were not found in smelt stomachs at other times. Creaser (1925) also found small quantities of smelt eggs in the stomachs of smelt captured in the spawning run in Cold Creek, Michigan.

Stomachs of 12% of the adult smelt taken on their spawning grounds in the Pefferlaw River contained Emerald Shiners. At other times of the year fish were found in the stomachs of 8.6% of the adult smelt examined and were primarily young-of-the-year smelt in summer and fall, and salted Emerald Shiners in winter. The selection of fish at certain seasons has been reported in other papers. For example, 97.3% of the stomachs of 147 smelt taken in Crystal Lake, Michigan in September contained Emerald Shiners (Creaser 1925). Larvae of the Cisco (*Coregonus artedii*) were found in 17% of the stomachs of smelt taken in May from Black Bay of Lake Superior (Selgeby et al. 1978). In Lake Huron, Emerald Shiners were found in 8% of smelt stomachs but only in July and August, and young-of-the-year smelt were found in 23% of smelt stomachs but only in September (Gordon 1961). In New York State, the food of the large race of Lake Champlain smelt contained a lower

percentage of fish during June and July, while, in the Saranac Lakes, fewer fish were eaten in summer (Greene 1930). Similarly, in Lake Erie, fish occurred in only 2.3% of smelt stomachs in spring and summer, but increased to 51.2% during the autumn (Price 1963).

There is no evidence from any study, including this one, that any segment of the smelt population becomes totally piscivorous, either on a seasonal or permanent basis; or that smelt predation is an obvious factor in the suppression of any sympatric population. The feeding selectivity of the Rainbow Smelt, however, could exert competitive pressure on specific food items required at some critical stage in the development of other fish species. For example, during the summer Lake Simcoe smelt eat more *Leptodora kindtii* even though smaller cladocerans are more abundant. Also Reif and Tappa (1966) suggest that the differential predation of stocked smelt on zooplankton in Harvey's Lake, Pennsylvania, has resulted in the disappearance of *L. kindtii* and the replacement of the larger *Daphnia pulex* by the smaller *D. dubia*. It is possible that competition for copepods between adult smelt and larval lake Cisco has led, in part, to the decline of the Cisco in the waters of western Lake Superior (Anderson and Smith 1971).

Thus, in considering possible impacts of an invading fish species on the welfare of indigenous species, such as the relationship between the naturalized smelt and native Lake Trout (*Salvelinus namaycush*) and Whitefish in Lake Simcoe, a knowledge of relative diet and food preferences of the species at all stages of life, as well as ecosystem responses, is essential. The importance of the observed cannibalism on eggs and young-of-the-year smelt as a self-regulatory population control is not known but in view of the increasing abundance of the species is obviously not a serious constraint at the ambient stage of naturalization.

There are insufficient data on the food of other fish species in Lake Simcoe to permit consideration of the likelihood of important interspecific competition for food, nor is there evidence of predation by Rainbow Smelt on either the Lake Trout or Whitefish population. The significance on the Lake Simcoe biosystem of observed variations in the extent and composition of the diet of the Rainbow Smelt relative to season, sex, and size of fish is worthy of more profound investigation.

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Song Pattern of the Cypress Hills Population of White-crowned Sparrows

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A disjunct population of White-crowned Sparrows (*Zonotrichia leucophrys oriantha*) in the Cypress Hills of Alberta possesses a distinctive song pattern which differs markedly from that of birds of the same geographic race in the Rocky Mountains of western Alberta. This suggests that this population is truly isolated and does not exchange individuals with populations in the main range of the subspecies.

Key Words: White-crowned Sparrow, *Zonotrichia leucophrys oriantha*, Cypress Hills, Alberta, song dialects.

The Cypress Hills of southeastern Alberta and southwestern Saskatchewan support an island of mesic forest habitat surrounded by drier shortgrass prairie. The plateau averages about 450 m higher than the surrounding plains, and this higher elevation results in lower temperatures and higher precipitation. Consequently, the region shelters disjunct populations of many plants and animals characteristic of the coniferous forests of the montane or boreal regions of Canada (Halladay 1965).

Although it seems probable that many of these disjunct populations, including conifers (Thompson and Kuijt 1976) and land snails (Russell 1951), are completely isolated from other conspecific populations because of the problems of dispersal across long distances of inhospitable terrain, the situation is less clear for populations of mobile organisms such as birds. The Cypress Hills Plateau possesses disjunct populations of at least 12 passerine species, separated from other populations in the Rocky Mountains or boreal forest by gaps of 250–300 km. It is likely that conifer forests became established on the Cypress Hills via colonization from migrating belts of coniferous forest following the receding Laurentide ice sheet at the end of the Wisconsin glaciation, and were isolated by the expansion of the grassland steppe vegetation, beginning about 10 000 yr ago (Thompson and Kuijt 1976). The populations of montane or boreal birds may have been isolated in the Cypress Hills at this time, or they may have colonized the area somewhat later. A third possibility is that these populations are not truly isolated, but continuously exchange individuals with conspecific populations in other areas.

The disjunct population of White-crowned Sparrows (*Zonotrichia leucophrys*) breeding in the Cypress Hills is assigned to *Z. l. oriantha*, a black-lored race that also inhabits the Rocky Mountains from southern Alberta and British Columbia south to northern New Mexico, and west to south central Oregon and central eastern California (American Ornithologists' Union 1957). Although the Cypress Hills population differs in mensural and plumage characters from other populations of *oriantha*, this variation is of a clinal nature and does not warrant taxonomic separation (Banks 1964). Local populations of White-crowned Sparrows, particularly the Pacific coast races *Z. l. nuttalli* and *Z. l. pugetensis* (Marler and Tamura 1962; Baptista 1975, 1977), may be characterized by distinctive song "dialects." Whether these dialects are an adaptation to reduce gene flow between populations, as suggested by Nottebohm (1969, 1970), is unclear, but they certainly may act as markers for groups of birds with little exchange of individuals (Baptista 1975).

During the summer of 1978 I had the opportunity to record songs of White-crowned Sparrows in the Cypress Hills. This paper describes the song pattern of this population and uses this evidence to suggest that this population is indeed isolated.

Methods

Recordings were made in Cypress Hills Provincial Park, Alberta, 5–8 June 1978. A minimum of 15 individuals were taped along the eastern and northern sides of Reesor Lake and in the valley of Battle Creek. Other birds were heard but not recorded. The sparrows were singing strongly in clumps of bushes, mostly hawthorn (*Crataegus* spp.), roses (*Rosa* spp.), and Buckbrush (*Symphoricarpos occidentalis*), adjoining patches of open grassland.

Songs were recorded with a Nagra 4.2 tape recorder and a Gibson E. P. M. parabolic microphone. Sonagrams were prepared with a Kay Elemetrics 6061B Sona-Graph, using the wide-band filter and high-shape setting.

Results and Discussion

Of the 15 males whose songs were recorded, 14 possessed the black lores characteristic of *oriantha*. One male at Reesor Lake, however, had white or pale gray lores, a character found in the northern race of the species, *Z. l. gambelii*.

Representative songs of each of the 15 males are shown in Figure 1. With one exception, all are similar. They consist of a more or less segmented introductory whistle, a pair of warbled syllables, two buzzes, and a terminal slow trill. Although there is some variation in the form of the warbled syllables among birds, this is minor and all are clearly variants of the same pattern. Approximately 6–10 other males that were heard but not recorded possessed songs of this common pattern.

The one exception (Figure 1O) had a song in which the terminal trill was absent and the pair of warbled syllables was replaced by a four-note segment with a very different sound quality. The absence of the trill may not be significant because birds frequently sing incomplete songs; however, none of the songs heard from this male over a period of about 20 min had the trill, and all had the four-note segment. The male with the unusual song was not the individual with the *gambelii* phenotype. The latter bird's song (Figure 1C) was comparable to those of other males of this population.

The song pattern of White-crowned Sparrows in the Cypress Hills is markedly different from the "typical" song of *oriantha* in the Rocky Mountains of southern Alberta, the nearest conspecific population. Figure 2 shows songs of birds from three localities in the Rockies, spanning a distance of approximately 200 km from Waterton Lakes National Park in the south to the Highwood Pass in the north. All have similar songs, with three whistled notes in place of the warbled syllables of the Cypress Hills birds, and a terminal trill consisting of simpler notes than those of Cypress Hills songs. No songs resembling those of Cypress Hills birds have been recorded in the Rocky Mountains of Alberta.

The sharp differences between the songs of Cypress Hills birds and those of birds from the Rocky Mountains of Alberta suggest that there is little, if any, exchange of birds between these two *oriantha* populations, and that the Cypress Hills White-crowned Sparrows form a discrete population. Because juvenile birds probably learn their song prior to dispersing from their natal area (Marler 1970), any bird immigrating to the Cypress Hills from another population would be expected to sing a different song pattern. The apparent absence of songs resembling those of montane *oriantha* suggests that there is little influx of birds from this area.

Other disjunct populations of White-crowned Sparrows are found on other montane "islands" in Montana (Thompson 1978). The song patterns of these populations are unknown. But the fact that White-crowned Sparrows are absent from the Sweetgrass Hills (100 km WSW of the Cypress Hills and 140 km E of the Rocky Mountains) although suitable habitat is available (Thompson 1978), also suggests a low rate of immigration of birds from the main range into outlying populations.

The general similarity of songs of birds over a wide area in the Rocky Mountains (Figure 2) argues that there is considerable exchange of birds between populations in this region. Studies of *oriantha* populations in California and Colorado (Baker 1975; Orejuela and Morton 1975), however, have demonstrated the existence of dialects in the songs of populations separated by only 16 km. This suggests that population structure, dispersal, and the development of song dialects may show a considerable amount of variation within this single subspecies.

There are several possible explanations for the presence of a white-lored bird in the Cypress Hills. Migrant *gambelii* have been recorded there (Taverner 1927; Rand 1948), and this individual may represent the result of past introgression. But birds with white lores have been collected on several occasions far to the east of the range of *gambelii*, or any of the other white-lored races (Rand 1948), and this may be a character that is exhibited occasionally in generally black-lored populations.

The one individual with an aberrant song (Figure 1O) may have copied the song of another population (Baptista 1974) or it may reflect an error in song-learning (Baptista 1975).

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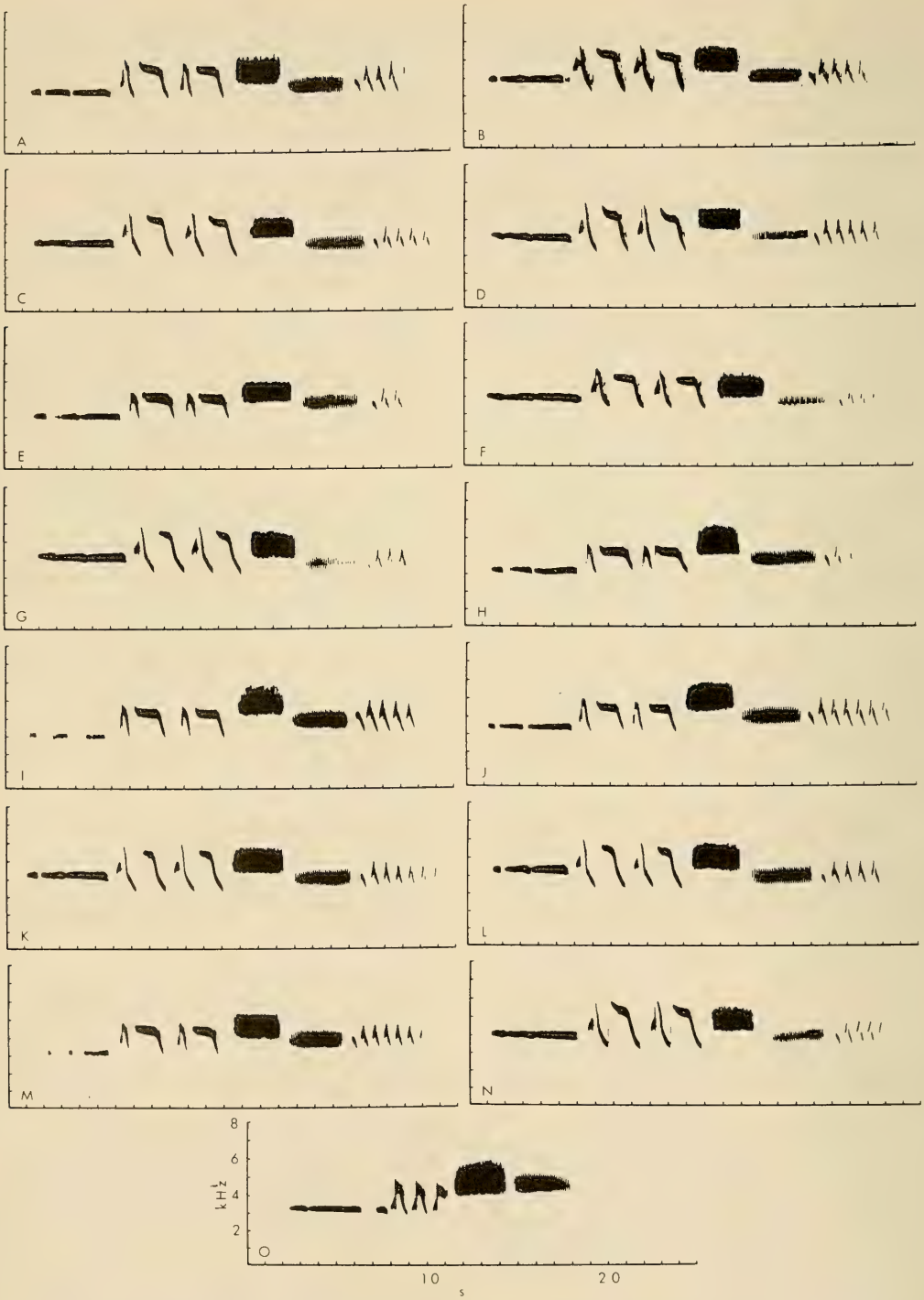

FIGURE 1. Songs of male White-crowned Sparrows from Cypress Hills Provincial Park, Alberta. 1C is the song of a white-lored bird; all others are songs of black-lored birds. Time scale is in seconds. Each division of ordinate scale is 1 kHz.

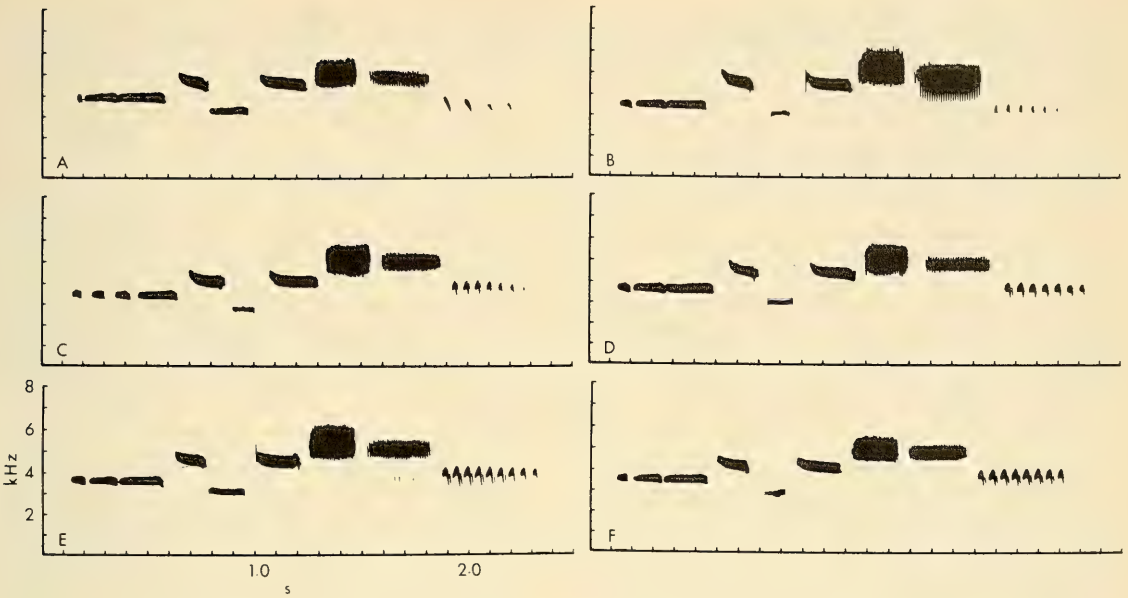

FIGURE 2. Representative songs of *oriantha* White-crowned Sparrows from the Rocky Mountains of Alberta. 2A and 2B are from Waterton Lakes National Park; 2C and 2D are from the Sheep River Valley; and 2E and 2F are from Highwood Pass, Kananaskis Valley. Time scale is in seconds.

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Nesting Biology and Development of Young in Ontario Black Terns

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Habitat, nesting substrate, egg characteristics, and growth are described for Black Terns (*Chlidonias niger*) nesting on Lake Erie. Black Terns prefer moderate density of emergent vegetation (mainly *Typha*) in about 1 m of water, adjacent to open water, and return to the same nest site or area as long as it is suitable. Egg and growth characteristics are similar to those for other temperate-nesting tern species. Minnows form a good portion of the biomass consumed by chicks in this area.

Key Words: Black Terns, *Chlidonias niger*, nesting, growth, egg characteristics.

Black Terns (*Chlidonias niger*) nest widely throughout southern Canada, but their breeding biology is not well known. As the preferred habitat is cattail (*Typha* spp.) marsh with a metre or more of water, and the young after the first 2 or 3 d leave the nest when disturbed, accessibility for observation is restricted. Only one intensive study of breeding biology has been done (Cuthbert 1954), and this included few data on development of young. This paper fills in some gaps in knowledge of nesting biology and gives the first data on growth of chicks.

Methods

This study area was an approximately 15-ha marsh on the north side of Long Point, near Port Rowan, Ontario (42°35'N, 80°24'W). A description of the vegetation and bird life is given in Dunn and Nol (1976), and mammals seen in the area were Muskrats (*Ondatra zibethicus*) and Mink (*Mustela vison*).

A canoe was used to traverse the study area. There were approximately 30–40 Black Tern nests in the area, in small groups. Twenty-three nests in four groups were studied in 1975 and 32 in five groups in 1976.

Nests were identified with tagged 2-m stakes pushed into the mud. Eggs were marked with indelible felt-tip marker, and measured with dial calipers to the nearest 0.01 mm (length and width at broadest point), and were weighed several times during incubation to the nearest 0.1 g with a Pesola spring balance. Occasionally eggs were floated in a beaker of fresh lake water to determine degree of development (Hays and LeCroy 1971).

Fences of hardware cloth were placed around the nests during incubation to prevent the young from leaving the nest site during development. The fences were 0.4–0.5 m in diameter and 0.3 m high. The adults readily incubated and cared for young within the fences, and early placement made it easier to catch adults later in roofed traps of similar size, with entrance holes in the top. Adults and young were banded with U.S. Fish and Wildlife Service aluminum bands. Color bands were used on adults until it became clear that they were almost never visible.

Chicks were weighed every 1 or 2 d to the nearest 0.1 g, and tarsus and ulna were measured with the adjacent bones held at right angles. Measurements of skull were from bill tip to back of the skull, with the ruler held parallel to the bill; and of culmen from bill tip to feather line on the upper mandible. Sheath and feather length were measured for the 9th primary, outer rectrix, and a few body feathers on the anterior parts of dorsal and ventral tracts.

On four occasions, observations of nests were made from a blind mounted permanently on an anchored rowboat.

Results and Discussion

Black Tern nests were formed of dead cattail, most commonly on a pre-existing mat of floating dead

TABLE 1—Percentage of Black Tern nests built on various substrates: A, Ontario (N = 24)—this study; B, Michigan (N = 23)—Cuthbert (1954); C, Iowa (N = 197)—Bergman et al.; D, California (N = 40)—Gould (1974)

	A	B	C	D
Floating dead vegetation	75	48	11	15
Floating boards or logs	17	22		33
Cattail rootstock	8		53	
Muskrat-built structures[a]		22	36	33
Abandoned birds' nests[b]				20
Broken-down bulrushes		9		

[a]Muskrat lodges or feeding platforms of freshly cut vegetation.

[b]Platforms of old grebe (*Podiceps*) and Forster's Tern nests. Black Terns have also been found nesting on abandoned American Coot (*Fulica americanus*) nests (Cuthbert 1954).

cattail lodged in emergent vegetation (Table 1). No nests were found on Muskrat houses or feeding platforms, although these were abundant. The majority of substrates were floating, in water 1–1.2 m deep. A few nests in a nearby marsh were found on isolated small patches of soft mud, but these nest sites were otherwise normal (see below). Black Tern nests on dry land are rare (Cuthbert 1954; Richardson 1967). These terns are opportunistic in the choice of supporting structure for their nests, although in my study floating vegetation and boards seemed to be preferred over Muskrat houses (Table 1). Previous papers have not commented on the relative availability of other substrates.

Nest characteristics were described for 25 nests. Typically, they were about 2–5 cm high and 25 cm across. The underlying mats of dead cattail were lodged in living cattail, usually with heavy growth on at least one side, and averaged 8 m^2 (ranging from 0 for a nest on a board to 417 m^2 in area). Open water was, on average, 4 m away (range: 0.5–12 m). Some nests were in large pools, and these were generally on boards or rootstock, depending less on emergent vegetation to support the nest substrate. Moderate cattail growth seemed preferred (standing at least 1 m above the water but dispersed enough so that a canoe could be forced through). A few nests were in thin new growth, but were rare in dense old stands. Other studies show that the species composition of aquatic vegetation at Black Tern breeding sites varies markedly, but that its density is usually moderate. Water is usually 1 m deep and nests normally are adjacent to open water (Cuthbert 1954; Richardson 1967; Bergman et al. 1970; Gould 1974).

Although nests were usually well spaced (only 2 or 3 within a 25-m^2 area), a few were within 3 m, with a clear view between them. Groups had up to 10 nests, and probably resulted from chance distribution of good sites. About one quarter of all nests were not near other tern nests. This dispersion of nests is typical (Cuthbert 1954; Gould 1974), although nests may occasionally be much closer together (Hoffman 1926).

Because floating vegetation became waterlogged by late July and winter storms altered nest-site characteristics, and because water levels and cattail growth alter over a period of years, terns must seek new nest sites each year. McNicholl (1975) predicted that under these circumstances, the birds would continue to use a nesting area as long as the habitat is suitable, but when they must move, they would go as a group to a new site. This is in contrast to the site tenacity demonstrated by several gull and tern species with permanent nesting areas.

A few re-trap data suggest that Black Terns do return to the same general location of a previous breeding site and will nest there again if possible. Of five birds trapped in 1976, which had been banded previously, one was at nearly the same nest site as in 1975 and another was within the same general locality, probably moving less than 50 m. (Changes in habitat between years made exact mapping difficult.) Two birds banded in 1972 were also found in 1976 within a short distance of the banding site. The fifth bird moved farther, about 75–100 m, but was still within the same patch of marsh vegetation as in 1975.

The Black Terns in my study moved in 1977, after winter storms had so altered the habitat that no suitable floating platforms were available for nest substrates. So many Black Terns nest in the Long Point marshes, however, that it would have been impractical to trap other areas to determine whether McNicholl's (1975) prediction on group adherence held true.

The outcome of the 55 nests located during the 2 yr is given in Table 2. The majority of known losses occurred in the egg stage. In most cases, eggs disappeared or did not hatch, and a few nests were destroyed by storms. Undoubtedly, some losses resulted from my activities (eggs cracked during trapping of adults, young in retaining fences eaten by Mink). Nevertheless, Bergman et al. (1970) showed a very similar success rate (29% of 192 nests) in a much larger study with no handling of eggs or birds. There was no correlation between success and nest-site characteristics either in my study or in that of Bergman et al. (1970).

There were no significant differences in measurements of eggs according to sequence in the clutch

TABLE 2—Success of Black Terns nests

	1975		1976		Total	
	No.	%	No.	%	No.	%
Successful[a]	9	39	6	19	15	27
Unsuccessful	9	39	23	72	32	58
Undetermined	5	22	3	9	8	15
Total	23		32		55	

[a]Young hatched, but later fate may have been unknown. Nests in which all chicks were known to have died were classified as unsuccessful.

TABLE 3—Mean ±SD (N) weights and measurements of Black Tern eggs

	Egg 1	Egg 2	Egg 3	All eggs
Weight (g)	10.63 ± 0.96 (8)	11.42 ± 0.51 (6)	10.92 ± 0.45 (6)	10.95 ± 0.76 (20)
Length (mm)	33.96 ± 0.98 (19)	34.32 ± 1.45 (13)	34.51 ± 1.13 (20)	34.34 ± 1.32 (91)
Width (mm)	24.88 ± 0.63 (19)	25.32 ± 0.57 (13)	24.73 ± 0.45 (20)	24.92 ± 0.62 (91)
Shape index[a]	74.04 ± 2.67 (15)	74.22 ± 2.84 (12)	72.00 ± 2.69 (18)	72.69 ± 3.72 (74)

[a]100 × width/length (Collins and LeCroy 1972).

(Table 3), although third eggs were longer and narrower and had a lower shape index (Collins and LeCroy 1972). There was a tendency for the first egg to be smallest and the second to be largest (Table 4). In contrast, the smallest egg for Common Terns (*Sterna hirundo*) is usually the third one. As in Black Terns, the third egg is usually the most narrow (Gemperle and Preston 1955; Gochfeld 1977). Fresh egg weight of Black Terns was 17.3% of adult body weight, a slightly lower percentage than shown by the larger Common and Roseate Terns (*S. dougallii*) (Collins and LeCroy 1972).

TABLE 4—Percentage of Black Tern nests in which given eggs in the laying sequence were largest, of middle size, or smallest in the clutch. N = 10 clutches. Volume calculated as per Shott and Preston (1975)

	Egg 1	Egg 2	Egg 3
Largest in clutch	10	60	30
Medium sized	30	30	40
Smallest in clutch	60	10	30

Development of embryos could be followed through flotation of eggs. The pattern for Black Terns is very similar to that in Common Terns (Hays and LeCroy 1971), although Black Tern eggs sometimes float a day earlier (Table 5). Not enough eggs were floated to give further details, but within a clutch, the degree of flotation normally indicated the true laying sequence. Incubation begins after laying of the first egg and eggs are usually laid a day apart (Haverschmidt 1945), so that the eggs are graded in amount of incubation.

TABLE 5—Flotation and hatching schedule of Black Tern eggs

Days after laying of egg	Development
6 – 7	Vertical, sits on pointed end
8	Some eggs float
10 – 11	Last eggs float
19 – 20	Eggs pip
20 – 22	Eggs hatch

Weights of three freshly hatched chicks averaged 7.25 g, and subsequent growth is detailed in Figures 1–3. The average weight for day 0 (day of hatch) chicks in Figure 1 includes birds which may have been hatched as much as 10–20 h before being weighed. Weight gain in the chicks shows a pattern very similar to that of other temperate-nesting species. The growth curves of terns can best be fitted to logistic equations, and growth constants calculated for various species are compared in Table 6. Although Black Terns appear to grow more rapidly than the other terns, they

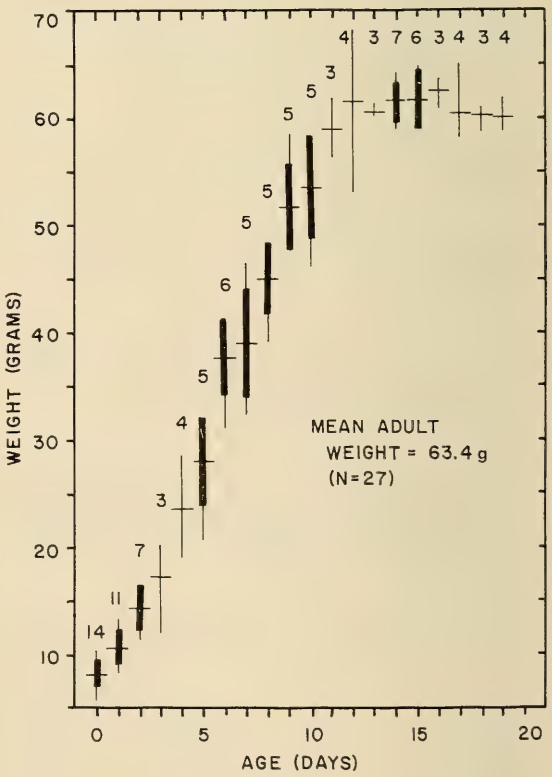

FIGURE 1. Weights of Black Tern chicks. Horizontal bar shows mean, heavy vertical gives SD, and thin vertical bar indicates range. The numbers indicate sample size.

TABLE 6—Comparative growth in northern-nesting tern species

Species	K[a]	t_{10-90}[b]	Adult wt., g	Source
Black Tern	0.365	12.1	63	This study
Arctic Tern	0.288	15.2	104	Ricklefs 1973
Common Tern	0.300	14.6	125	Ricklefs 1973
	0.238	18.5	116	LeCroy and Collins 1972
Roseate Tern	0.237	18.5	108	LeCroy and Collins 1972
Sandwich Tern (*Sterna sandvicensis*)	0.258	17.0	237	Ricklefs 1973

[a]A constant relating to the growth curve, representing rate at which asymptotic weight is attained. Calculated according to Ricklefs (1967).
[b]Time in days between achieving 10% and 90% of asymptotic weight (Ricklefs 1967).

are also much smaller as adults. Comparisons of growth in relation to asymptotic weight between Black Terns and other semi-precocial gulls, terns, and skuas (Table 6; Ricklefs 1973, p. 188) suggest that the Black Tern has a typical growth rate for its size.

Although few chicks were followed through the entire growth period, some clearly lagged behind in weight gain, as is also seen in other tern species (e.g., Langham 1972). In contrast to what LeCroy and Collins (1972) found for Common and Roseate Terns, however, feather growth in laggard Black Tern chicks was also retarded. The weight loss which occurred after attainment of asymptotic weight (close to adult weight) is also common in other terns (LeCroy and Collins 1972; LeCroy and LeCroy 1974).

Of the weight and linear measures shown in Figures 1 and 2, no single one proved suitable for aging chicks accurately in the field, although skull length was helpful for younger chicks and culmen length for older ones. Considered all together, these average measurements can be used to estimate the age of an unknown chick within a 3- to 4-d range. The tarsus reaches full adult length in the chicks well before fledging, but skull and culmen must both continue to grow after first flight (Figure 2).

Growth of the body feathers levelled off by the end of the weight increase period, but both tail and wing feathers were still growing rapidly. The latter in particular can be helpful in aging nestlings (Figure 3), as was also found for Common and Roseate Tern chicks (LeCroy and Collins 1972).

The egg tooth in 10 chicks dropped off before day 5, and in one case, on day 1 or 2. Typically it seems to disappear on day 3 or 4, making this species similar to Common, Forster's, and Arctic Terns (*Sterna paradisaea*), but faster in losing the egg tooth than Roseate or Least Terns (*S. albifrons*) (McNicholl 1971; LeCroy and Collins 1972).

On four occasions, observations of nests with single chicks were made from a blind mounted on a rowboat. The watches totalled 7 h for a chick 5 d old, 2.25 h for a 15-d-old, and 5.25 h for two 19-d-olds in separate nests. These watches were too few to support general conclusions on behavior, but certain observations are worth noting. The single 5-d-old chick was fed more often than the older ones, and was the only one brooded. It was fed 5.4 times per hour, as opposed to 3.6 per hour for the 15-d chick and 1.7 times per hour for each of the two 19-d chicks. Brooding took place for 14% of the observation period. These figures correspond well with those of Cuthbert (1954), who made much lengthier observations of chicks less than 9 d old. There is apparently an increase in feeding rate over the first few days, then a decline after about 10 d, when most weight gain is complete.

Of 602 feedings observed by Cuthbert (1954), 5% of the items were minnows, 3% dragonflies and, overall, 93.6% were insects. Of the 56 food items seen in this study, 13% were minnows, and 6% were dragonflies. The remainder were usually unidentifiable small objects (therefore probably not minnows) and seemed to include many grubs and larvae. Although often described as primarily insectivorous, Black Terns clearly use fish as a substantial portion of the food fed to chicks. Given the large size and digestibility of the minnows as compared to insects (Dunn 1973), fish probably provide at least one-third of the protein required by the growing chicks.

Begging, feeding, and brooding behaviors corresponded closely to those described in detail by Cuthbert (1954) and Baggerman et al. (1956). One parent seemed to bring mainly fish to the nest, while the other brought small items, often in series of closely spaced feedings.

Most of the chicks' non-feeding activity consisted of preening, walking, or resting, and occasionally picking up and immediately dropping bits of vegetation. There was a notable change in behavior by 19 d of age, when the chicks spent a good deal of time flapping their wings and hopping into the air. Five chicks disappeared from the retaining fences on day 19, only one stayed longer; earlier departures were

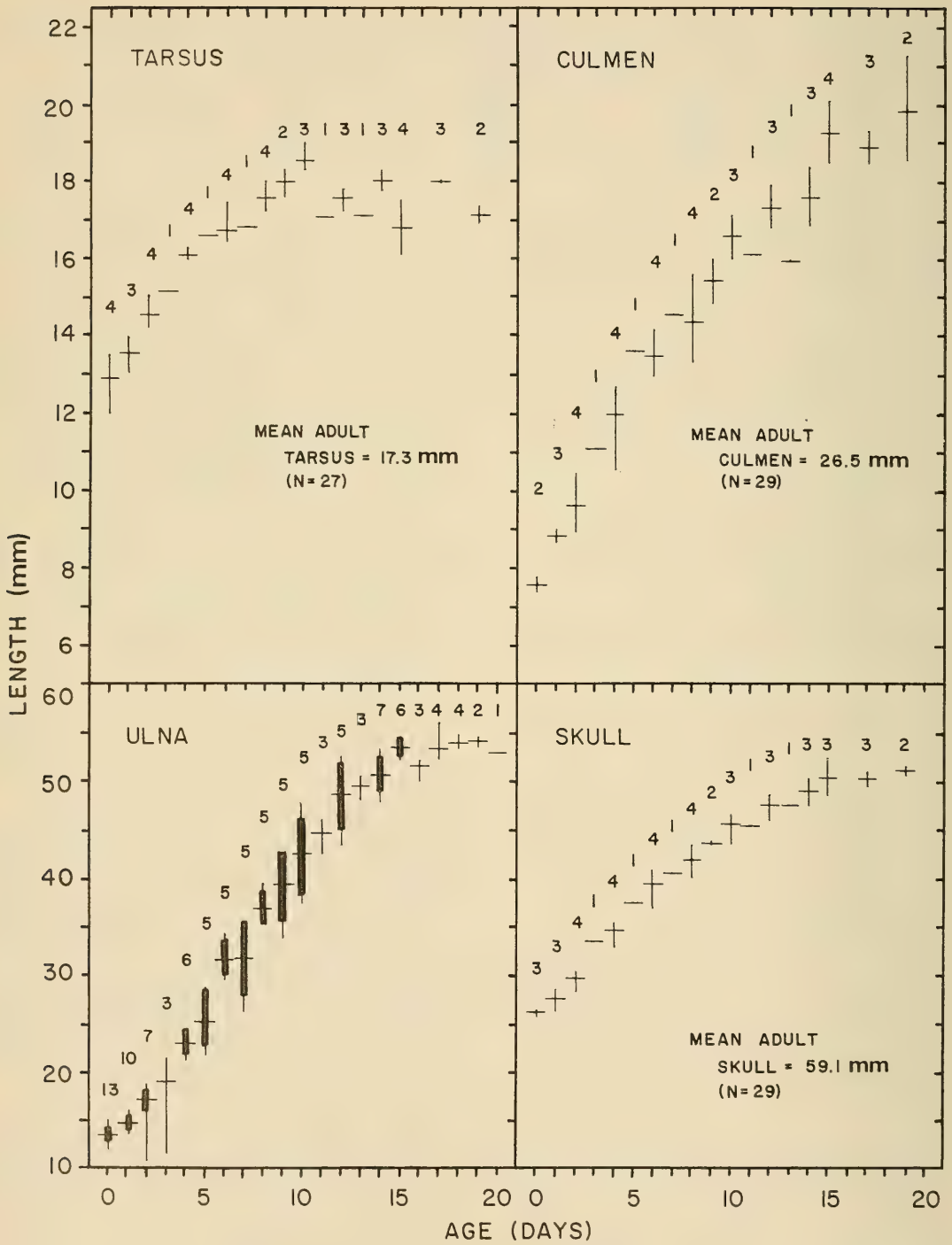

FIGURE 2. Measurements of Black Tern chicks. Legend as in Figure 1.

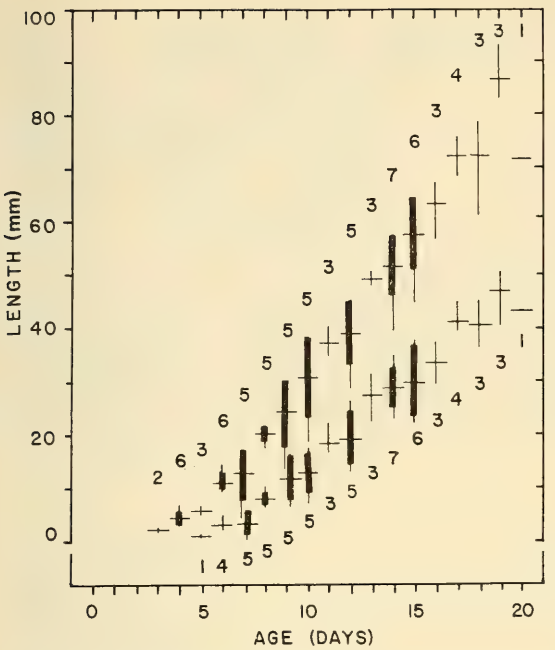

FIGURE 3. Development of feathers in Black Tern chicks (total length, including sheath). Legend as in Figure 1. Upper bars indicate length of 9th primary, lower bars show outer rectrix growth.

believed to be caused by predation or faulty fencing. The chick that was underweight throughout the growth period stayed inside the fence the longest. Delayed fledging of underweight Common Terns was noted by LeCroy and LeCroy (1974). I originally thought disappearances of young represented first flights, but the last occurrence took place while the nest was under observation. The chick flapped its wings and barely hopped the fence, then swam away. Exact age of fledging is undetermined, but must be close to 19 d. Baggerman et al. (1956) said flight first occurred 3 wk after hatching, but Cuthbert (1954) felt it was closer to 25 d after hatching.

Black Terns are very similar to other temperate-nesting species in both egg and growth characteristics, even though other species studied to date are primarily piscivorous and nest along marine shores rather than in marshes.

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Summer, Autumn, and Winter Diets of Elk in Saskatchewan

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Hunt, H. M. 1979. Summer, autumn, and winter diets of Elk in Saskatchewan. Canadian Field-Naturalist 93(3): 282–287.

The composition of the contents of 88 Elk (*Cervus elaphus*) rumens obtained in summer, autumn, and winter from the boreal forest region of east-central Saskatchewan demonstrated that woody browse was the preferred forage of Elk. Relatively constant amounts of forbs (13–17% of rumen contents) and sedges (*Carex* spp.) and grasses (7–8%) were present in the rumens in each season. Cultivated crops made up over one-quarter of the forage found in autumn rumens. Summer rumen compositions were characterized by similar high proportions of browse in rumens from each of four areas in east-central Saskatchewan and slight variations from area to area in the minor amounts of sedges and grasses, forbs, and agricultural crops. Significant differences from area to area in the individual component foods in each broad forage class in the rumens demonstrated the variable and adaptable nature of the diet of Elk in Saskatchewan.

Key Words: Elk, food, browse, Saskatchewan, *Cervus elaphus*.

Extensive habitat alteration has occurred in the boreal forest of Saskatchewan as a result of increased timber utilization and accelerated land clearing for agriculture along the forest fringe. Knowledge of the seasonal composition of the diet of any wildlife species is basic to understanding its ecology, particularly in terms of how habitat changes may affect food quantity and quality. An investigation of the diet of Elk or Wapiti (*Cervus elaphus*) in the boreal forest was undertaken because other food studies did not appear to be directly applicable to Saskatchewan Elk. In a review of 48 studies of the foods eaten by Elk in the western United States, Kufeld (1973) determined that grasses were the preferred forage of Elk in all seasons except summer when forb use was high. In the only published study of Elk diet in habitat closely comparable to Saskatchewan's boreal forest, Riding Mountain National Park in Manitoba, woody browse was the preferred forage with grass and grass-like plants abundant in the diet only in spring and early winter (Blood 1966).

Study Areas and Methods

From 1973 to 1977, contents of 88 Elk rumens were sampled from the Porcupine Forest, the Squaw Rapids area, the Fort à la Corne Wildlife Management Unit, and the region surrounding Candle Lake in east-central Saskachewan (Figure 1). The distribution of rumen samples by area and season is given in Table 1. The Porcupine Forest is predominantly a Trembling Aspen (*Populus tremuloides*) forest with some mixedwood (aspen – White Spruce (*Picea glauca*)) portions. The Squaw Rapids area consists of aspen and Balsam Poplar (*Populus balsamifera*) stands, mixedwood stands (aspen – Balsam Poplar – White Spruce, aspen – Jack Pine (*Pinus banksiana*)) and softwood stands (Black Spruce (*Picea mariana*)) along the Saskatchewan River, and the sedge (*Carex* spp.) meadow – willow (*Salix* spp.) complexes of the Cumberland Delta of the Saskatchewan River. Aspen, aspen – Jack Pine, and Jack Pine stands characterize the Fort à la Corne Wildlife Management Unit whereas the area around Candle Lake is typical of the mixedwood section of the boreal forest as described by Rowe (1972) with aspen, White Birch (*Betula papyrifera*), White Spruce, Jack Pine, Black Spruce, and Tamarack (*Larix laricina*) the main tree species. Nomenclature for the vascular plants follows Moss (1959) and Budd and Best (1969); most common names are taken from Budd and Best (1969).

The mean daily temperature in January in east-central Saskatchewan is about –20°C; mean July temperature is about 18°C. Annual preciptation averages about 42 cm, approximtely two-thirds of which falls as rain from April to October. Yearly snowfall averages about 130 cm and mid- to late winter snow depths average about 45 cm.

Causes of death of the sample animals were collisions with automobiles (8) and trains (1), sport-hunting (53), unregulated hunting (7), winter mortality (1), and a biological collection program (18). The rumen samples were from 5 male calves, 48 adult males, 3 female calves, 23 adult females, and 9 animals

TABLE 1—Distribution of rumen samples by area and season

Season	Area			
	Porcupine Forest	Squaw Rapids	Fort à la Corne	Candle Lake
Summer	28	5	13	4
Autumn	12	—	3	—
Winter	13	1	1	8
Total	53	6	17	12

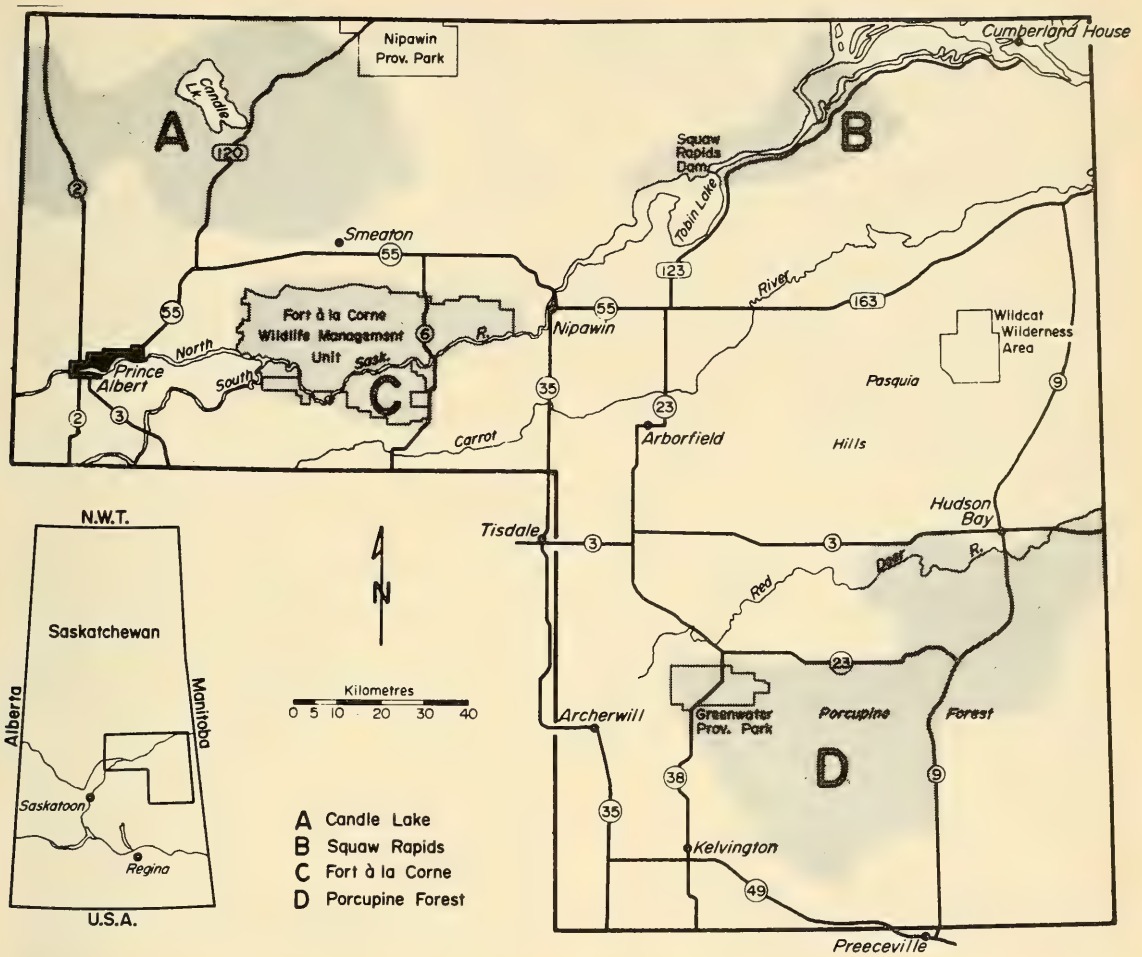

FIGURE 1. Approximate limits of Elk range in east-central Saskatchewan from which the Elk rumens were obtained.

of unknown sex and age.

Most rumen samples were stored by freezing as suggested by Korschgen (1971) but a few were preserved in 10% formalin. After thawing, a 1.1-L (1-qt) aliquot of rumen content was washed through a 5.66-mm mesh screen (U.S. Standard Sieve Series Mesh No. 3½) following Dirschl's (1962) recommendation. The material remaining on the screen was placed on a white enamel tray, covered with water, and separated into pre-weighed petri dishes using forceps. Rumen components were identified macroscopically to the lowest taxonomic level possible. Mushrooms were not identified beyond order, and grasses were identified only to family (Gramineae); fine material was sorted by forage class as unidentified herbaceous material or unidentified woody material. Dry weights of the components were recorded after they had dried for 24–48 h at 70°C.

Data for the identified portions of the samples were grouped according to region and season regardless of sex or age class. The grouped data are presented by the aggregate percentage method of Martin et al. (1946). Seasonal groupings were made primarily according to plant phenological developments described by Stewart et al. (1977), and correspond approximately to the periods 15 June – 30 September (summer), 1 October – 30 November (autumn), and 1 December – 30 April (winter). Summer represented the period following new vegetative growth in spring until killing frosts halted annual growth, and autumn was the non-green period following summer before snow depths became a critical factor influencing forage avail-

ability and elk mobility. Winter was the period characterized by snow cover and lower temperatures although this period did not end with the disappearance of snow but rather with the commencement of new vegetative growth.

Results and Discussion

Browse was the major component in the diet of the Elk in east-central Saskatchewan, especially in summer and winter (Figure 2). When leaves were available on the woody plants in summer and autumn, Elk consumed both leaves and twigs; twigs predominated in winter diets. Grasses and sedges were of minor importance in each season and forbs were of moderate importance. Agricultural crops were eaten when available in the autumn. Blood (1966) reported similar use of browse, grasses and sedges, and forbs by Elk in Riding Mountain National Park, Manitoba.

Elk ate a variety of browse species. Aspen was the most important browse species both in proportion of rumen contents and frequency of occurrence (Table 2). Willows, the second most frequently occurring browse species, were common in rumens from each season. Wild Red Raspberry (*Rubus strigosus*), rose (*Rosa* spp.), and High-bush Cranberry (*Viburnum trilobum*) were common forages in summer although rose was found frequently in rumens from each season. The 10 browse species occurring most frequently in the rumens were aspen (84% occurrence), willow (74%), rose (63%), Wild Red Raspberry (45%), High-bush Cranberry (34%), Red-osier Dogwood (*Cornus stolonifera*) (30%), Saskatoon (*Amelanchier alnifolia*) (15%), Jack Pine (15%), Choke Cherry (*Prunus virginiana*) (13%), and Pin Cherry (*Prunus pensylvanica*) (13%). The five most frequently occurring species accounted for 82% of the dry weight of the browse identified. Blood (1966) found rose, aspen, willows, and Saskatoon were the most important browse items in rumens from Riding Mountain National Park, making up about 87% of the total browse segregated. Kufeld (1973) listed Saskatoon, aspen, Choke Cherry, and willow as highly valuable Elk forages.

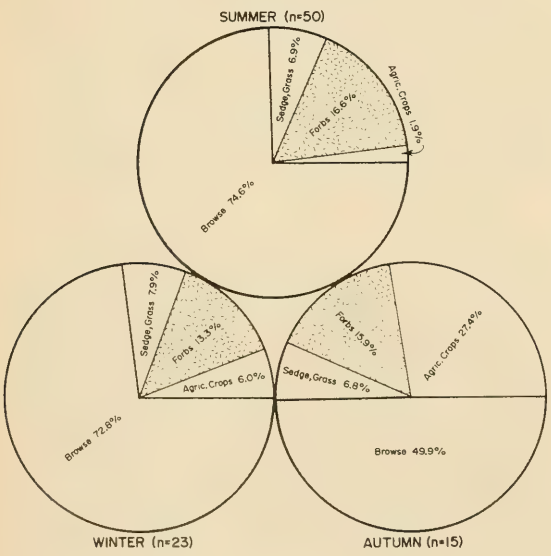

FIGURE 2. Composition of the rumen contents from Elk in summer, autumn, and winter in east-central Saskatchewan.

The abundance of most browse species in the rumens varied seasonally. Use of leaves of woody species was presumably related to their high levels of crude protein and total digestible nutrients as demonstrated by Stewart et al. (1977). Rose hips and the fruit and leaves of High-bush Cranberry were important foods in late summer. Significant use of fruits by White-tailed Deer (*Odocoileus virginianus*) has been reported by authors such as Healy (1971), Skinner and Telfer (1974), and Puglisi et al. (1978). Red-osier Dogwood was consumed in quantity only in autumn, and Pin Cherry was common only in summer and autumn rumens. Similar seasonal use of these two species by Moose (*Alces alces*) in Minnesota was reported by Peek et al. (1976). The frequency of occurrence of rose in the rumen samples decreased in winter probably because snow covered this low-growing shrub.

Forbs were eaten mostly in the summer and autumn but were almost as important in winter. In Elk rumens from Riding Mountain National Park, Blood (1966) found forbs comprised a higher proportion in the summer (26%) than in this study (17%), but only one-half the level noted in this study in autumn and winter. The principal forbs in the Saskatchewan rumens were Wild Vetch (*Vicia americana*), Cream-colored Vetchling (*Lathyrus ochroleucus*), Wild Peavine (*Lathyrus venosus*), Prickly Sow-thistle (*Sonchus asper*), Canada Thistle (*Cirsium arvense*), Fireweed (*Epilobium angustifolium*), and horsetail (*Equisetum* spp.), whereas the principal forbs in the Riding Mountain rumens were Wild Peavine, Cream-colored Vetchling, Dandelion (*Taraxacum officinale*), Fireweed, and Coltsfoot (*Petasites sagittatus*) (Blood 1966). In recent cutovers in Saskatchewan, proliferation of invader or pioneer plant species such as Prickly Sow-thistle and Canada Thistle provided a source of forage; similar forages were probably not available to Riding Mountain Elk as logging is not permitted there. Blood (1966) concluded that certain forbs in Riding Mountain National Park were eaten in excess

TABLE 2—Detailed seasonal composition of rumen contents from Elk in east-central Saskatchewan. Forages comprising <1% of the rumen contents are grouped into the "others" categories and the mean proportion of unidentified material in the samples is also included

Food categories	Summer (n=50)		Autumn (n=15)		Winter (n=23)	
	% Dry weight	Frequency	% Dry weight	Frequency	% Dry weight	Frequency
Trembling Aspen *(Populus tremuloides)*	11.9	72.0	20.7	100.0	26.4	100.0
Willow *(Salix* spp.*)*	7.5	70.0	1.5	73.3	15.9	82.6
Raspberry *(Rubus strigosus)*	11.6	62.0	—	—	—	34.8
Rose *(Rosa* spp.*)*	12.3	80.0	—	60.0	—	—
High-bush Cranberry *(Viburnum trilobum)*	16.3	48.0	1.7	4.0	—	—
Red-osier Dogwood *(Cornus stolonifera)*	—	—	8.3	66.7	3.2	39.1
Pin Cherry *(Prunus pensylvanica)*	4.4	18.0	2.1	13.3	—	—
Saskatoon *(Amelanchier alnifolia)*	—	—	1.3	20.0	—	—
Jack Pine *(Pinus banksiana)*	1.3	16.0	1.8	13.3	1.9	13.0
Choke Cherry *(Prunus virginiana)*	—	—	—	—	2.4	21.7
Honeysuckle *(Lonicera* spp.*)*	—	—	—	—	1.9	13.0
Others	3.4	—	3.4	—	2.0	—
Unidentified browse	5.9	44.0	9.1	73.3	19.1	52.2
Total browse	74.6		49.9		72.8	
Sedge *(Carex* spp.*)*	2.0	46.0	—	40.0	4.7	39.1
Grass	4.9	68.0	5.8	60.0	3.2	39.1
Prickly Sow-thistle *(Sonchus asper)*	1.2	22.0	5.9	33.3	2.7	17.4
Vetchling, Peavine *(Lathyrus* spp.*)*	4.2	22.0	—	—	1.3	13.0
Vetch *(Vicia americana)*	5.5	52.0	—	26.7	—	—
Mushroom	1.7	18.0	—	—	—	—
Fireweed *(Epilobium angustifolium)*	1.9	36.0	—	—	—	—
Horsetail *(Equisetum* spp.*)*	—	—	2.8	13.3	2.2	8.7
Canada Thistle *(Cirsium arvense)*	—	—	—	—	4.6	13.0
Alfalfa *(Medicago sativa)*	1.9	2.0	1.6	13.3	4.0	4.3
Barley *(Hordeum vulgare)*	—	—	10.8	40.0	—	—
Oats *(Avena sativa)*	—	—	5.9	33.3	—	—
Wheat *(Triticum aestivum)*	—	—	3.1	6.7	2.0	4.3
Cereal stems	—	—	6.0	26.7	—	—
Others	2.1	—	5.1	—	2.5	—
Unidentified herbs	—	—	3.1	20.0	—	—
Total herbs	25.4		50.1		27.2	
Unidentified material	37.6	96.0	40.4	93.3	21.7	86.9

of their availability while some other abundant forbs made up a small or negligible part of the diet. The same was probably true for east-central Saskatchewan.

Cultivated crops such as Wheat (*Triticum aestivum*), Oats (*Avena sativa*), Barley (*Hordeum vulgare*), and Alfalfa (*Medicago sativa*) were used extensively in autumn. This may cause significant conflicts along the forest-farmland interface, particularly in years of weather-delayed harvests. Elk use of agricultural crops was not mentioned by Blood (1966), and Alfalfa is the only agricultural crop present in the Saskatchewan rumens included in Kufeld's (1973) list of Elk forages. Agricultural crops may be particularly important to Elk in autumn for maintenance of good body condition prior to the lengthy period of negative energy balance that Stewart et al. (1977) describe as characteristic for Moose in winter.

Mid- to late summer rumen compositions for the four areas consisted predominantly of woody plant material (Figure 3). The minor amounts of sedges and grasses, forbs, and agricultural crops varied slightly from area to area. Examination of a more detailed breakdown of the rumen compositions for the four areas (Table 3) indicated that although the proportions of the browse forage class for each area were relatively similar, the individual component foods of the browse and other forage classes differed from area to area. For example, the proportion of aspen in the rumens ranged from over half at Candle Lake to only trace amounts at Squaw Rapids. Willows were

TABLE 3—Composition of the rumen contents from Elk in summer in four areas of east-central Saskatchewan. Forages comprising <1% of the rumen contents are grouped into the "others" categories and the mean proportion of unidentified material in the samples is also included

Food categories	Porcupine (n=28)		Squaw Rapids (n=5)		Fort à la Corne (n=13)		Candle Lake (n=4)	
	% Dry weight	Frequency	% Dry weight	Frequency	% Dry weight	Frequency	% Dry weight	Frequency
Trembling Aspen (*Populus tremuloides*)	7.3	71.4	—	—	13.3	84.6	53.7	100.0
Willow (*Salix* spp.)	2.9	57.1	2.2	60.0	15.1	92.3	21.9	100.0
Rose (*Rosa* spp.)	14.5	85.7	11.2	80.0	11.6	76.9	—	50.0
Raspberry (*Rubus strigosus*)	10.7	53.6	27.6	100.0	10.6	76.9	1.4	50.0
High-bush Cranberry (*Viburnum trilobum*)	21.2	60.7	41.4	100.0	1.1	15.4	—	—
Balsam Poplar (*Populus balsamifera*)	1.2	17.9	—	—	—	—	—	—
Pin Cherry (*Prunus pensylvanica*)	3.1	7.1	—	—	10.4	53.9	—	—
Manitoba Maple (*Acer negundo*)	—	3.6	—	—	—	—	—	—
Choke Cherry (*Prunus virginiana*)	—	—	—	—	1.1	15.4	—	—
White Birch (*Betula papyrifera*)	1.0	3.6	—	—	—	—	—	—
Currant, Gooseberry (*Ribes* spp.)	—	—	—	—	—	—	2.7	25.0
Jack Pine (*Pinus banksiana*)	—	—	—	—	4.2	53.9	2.4	25.0
Others	2.1	—	0.4	—	1.1	—	1.0	—
Unidentified browse	7.5	53.6	10.7	80.0	2.6	23.1	—	—
Total browse	71.5		93.5		71.1		83.1	
Sedge (*Carex* spp.)	2.5	53.6	1.5	60.0	—	—	2.4	50.0
Grass	8.0	75.0	—	—	1.5	76.9	—	—
Prickly Sow-thistle (*Sonchus asper*)	1.4	14.3	2.2	20.0	—	—	2.2	75.0
Vetchling, Peavine (*Lathyrus* spp.)	6.0	32.1	—	—	3.3	7.7	—	—
Vetch (*Vicia americana*)	5.3	57.1	—	—	9.2	53.9	—	25.0
Sarsaparilla (*Aralia nudicaulis*)	—	—	1.1	20.0	—	—	—	25.0
Fireweed (*Epilobium angustifolium*)	3.0	42.9	—	—	—	—	1.3	50.0
Cow-parsnip (*Heracleum lanatum*)	—	—	—	—	—	—	1.2	25.0
Mushroom	—	—	—	—	5.3	46.2	4.2	25.0
Lichen (*Cladonia* spp.)	—	—	—	—	—	—	2.9	25.0
Barley (*Hordeum vulgare*)	—	—	—	—	7.4	7.7	—	—
Others	0.9	—	1.7	—	2.2	—	2.7	—
Unidentified herbs	1.4	21.4	—	—	—	—	—	—
Total herbs	28.5		6.5		28.9		16.9	
Unidentified material	41.2	96.4	27.7	100.0	38.6	100.0	22.4	75.0

common in the rumens from the Candle Lake area and Fort à la Corne but less abundant in the rumens from the Porcupine Forest and the Squaw Rapids region. Pin Cherry was a significant component only in the samples from the Porcupine Forest and Fort à la Corne; Jack Pine was found only in rumens from Fort à la Corne and the Candle Lake area. High-bush Cranberry formed a major part of the food in rumens from the Porcupine Forest and Squaw Rapids area but was less common in rumens from the other areas. Mushrooms formed a large part of the non-woody forage in samples from both Fort à la Corne and the Candle Lake area whereas lichens (*Cladonia* spp.) appeared in notable quantity only in the rumens from the Candle Lake region. Deer have also been noted to eat mushrooms, but the significance of this is unknown (Healy 1971; Skinner and Telfer 1974). The cosmopolitan nature of the diet of Elk likely is a factor that enables them to thrive in many types of habitat.

This study demonstrates the importance of twigs and leaves of woody plants in the summer, autumn, and winter diet of Elk in east-central Saskatchewan in contrast to Kufeld's (1973) synthesis of Elk diets in the western United States in which grasses are the preferred forage. Land clearing along the forest fringe and subsequent planting of exotic grasses to enhance cattle production will make those areas less attractive to Elk as supplies of many of the preferred forages will be reduced. Clearcut logging in the commercial forest will stimulate production of most of the preferred Elk forages but forest managers must ensure that the proper balance between food and cover is maintained.

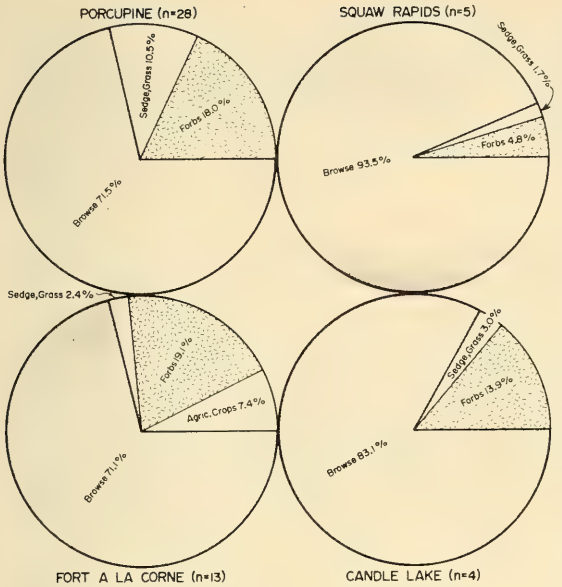

FIGURE 3. Composition of the rumen contents from Elk in summer from four areas in east-central Saskatchewan.

Acknowledgments

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Taxonomy, Distribution, and Ecology of the Cliff-brake Ferns (*Pellaea:* Polypodiaceae) in Alberta

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Brunton, Daniel F. 1979. Taxonomy, distribution, and ecology of the cliff-brake ferns (*Pellaea:* Polypodiaceae) in Alberta. Canadian Field-Naturalist 93(3): 288–295.

The genus *Pellaea* in Alberta consists of three species of calcicolous rock ferns. *Pellaea atropurpurea*, an apogamous triploid, is rare in the province. It is locally abundant in the Bow Valley of western Alberta, preferring hot arid sites on partially-shaded, heavily fractured limestone cliff-faces with a southwestern exposure. *Pellaea occidentalis*, a sexual diploid, is uncommon in Alberta but is locally abundant in the Bow Valley of western Alberta. It is found on arid south- or southwest-facing, open limestone cliff-faces. *Pellaea suksdorfiana*, an apogamous tetraploid, is uncommon in western Alberta where it ranges throughout the mountains. It prefers cool shaded, east- to north-facing limestone or calcareous sandstone cliff-faces, usually near water. *Pellaea occidentalis* and *P. suksdorfiana* are distinct from the eastern *P. glabella*, an apogamous tetraploid, on the basis of distinctive characteristics of range, morphology, cytology, and ecology. Characteristics for separating *P. suksdorfiana*, *P. occidentalis*, and *P. atropurpurea* are provided. Forty-five previously undocumented records for Alberta *Pellaea* are listed.

Key Words: *Pellaea atropurpurea*, *Pellaea occidentalis*, *Pellaea suksdorfiana*, taxonomy, distribution, ecology, cytology, Alberta, Polypodiaceae.

The cliff-brake ferns (*Pellaea*) have been described as "...comparatively rare in Canada or at most locally abundant..." (Rigby and Britton 1970). This statement still applies to the status of these small calcicolous rock ferns despite substantial additional study in parts of Ontario and Quebec (Lafontaine and Brunton 1972; Brunton and Lafontaine 1974). In western Canada the genus is represented by three species, *P. atropurpurea* (L.) Link, *P. occidentalis* (E. Nels.) Butters, and *P. suksdorfiana* Butters. The latter two are frequently treated as varieties of the eastern *P. glabella*.

This study was initiated to determine whether ecological evidence exists to support specific status for the three Alberta taxa of *Pellaea* and to gain a better understanding of its distribution and abundance in the province.

Taxonomy

The taxa of *Pellaea* in Alberta have been described under several names and/or combinations at a species and varietal level. Close morphological similarity has encouraged this, even though there are clear cytological differences (Tryon 1957). The three Alberta species of *Pellaea* are as follows:

1) *Pellaea atropurpurea* (L.) Link
2) *Pellaea occidentalis* (E. Nels.) Butters
   = *P. glabella* Mett. ex Kuhn var. *occidentalis* (E. Nels.) Butters
   = *P. glabella* Mett. ex Kuhn var. *nana* (Richards.) Cody
   = *P. pumila* Rydb.
3) *P. suksdorfiana* Butters
   = *P. glabella* Mett. ex Kuhn var. *simplex* (E. Nels.) Butters
   = *P. atropurpurea* (L.) Link var. *simplex* (Butters) Morton

Few authors today question the validity of *P. atropurpurea* as a distinct species (Tryon 1957, and others). It is an apogamous triploid (n and 2n = 87). It is also the largest species of Canadian *Pellaea*. It occurs across the country from British Columbia to Quebec and exhibits a distinctive morphology. The questions arise with *P. occidentalis* and *P. suksdorfiana*, which are often treated as varieties of *P. glabella*.

Pellaea occidentalis is a sexual diploid (n = 29, 2n = 58) and is a tiny plant of the dry interior of North America. *Pellaea suksdorfiana* is an apogamous tetraploid (n and 2n = 116) which is a species of the Cordilleran region of western North America. Both exhibit distinctive morphologies and ecology. The species with which they are often combined, *P. glabella*, is an apogamous tetraploid (n and 2n = 116). Although maintaining an equivalent cytology to that of *P. suksdorfiana*, it is disjunct from that taxon by over 1300 km. It is quite clearly different in morphology and cytology from *P. occidentalis*. Without the benefit of known ecological differences and with limited range data available, it is understandable that many authorities have preferred to treat these as one species. A. F. Tryon (Gray Herbarium, Harvard University, personal communication 1977) is in-

clined to retain this status for the utility of indicating relationships in the genus. On the basis of more complete range data and the demonstration of ecological preferences of each species which were observed during our study, we feel that there is sufficient evidence to justify each taxa being treated specifically.

Distribution and Ecology

Pellaea atropurpurea (Purple Cliff-brake) (Figures 1, 2).

This fern is known sparingly in Canada from British Columbia to Quebec. It is considered to be the rarest *Pellaea* in Canada (Rigby and Britton 1970), although recently it has been found to be locally abundant in

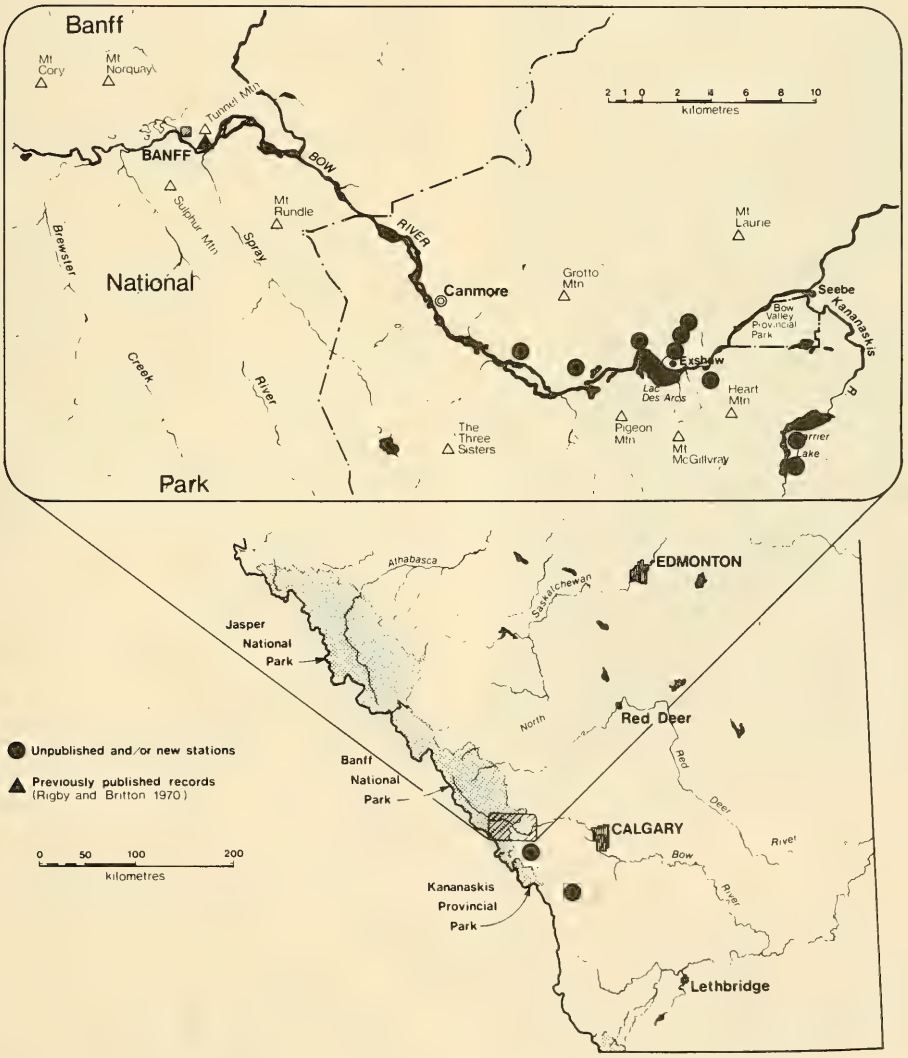

FIGURE 1. Distribution of *Pellaea atropurpurea* in Alberta.

parts of Ontario and western Quebec (White 1977).

Only recently noted in the province by the revision of a specimen collected in 1900 at Banff (Rigby and Britton 1970), it is now known from 11 sites in Alberta. These are all in or near the Bow Valley, a low dry valley in the eastern slopes of the Rocky Mountains. The additional stations are listed below. Herbarium acronyms follow Holmgren and Keuken (1974) with the exception of DFB which represents the author's personal herbarium.

FIGURE 2. Robust clump of *Pellaea atropupurea* growing in wide fissure in southwest-facing limestone cliff-face. Gap Lake, Exshaw, Alberta, 18 February 1978.

4 mi [6.4 km] E of Canmore, *Porsild 18147* in 1951 (CAN), *Brunton 1289* in 1976 (DFB,DAO, CAN); 1.5 mi [2.4 km] SE of Exshaw, *Bird 18500* in 1967 (UAC), *Brunton 1307* in 1977 (DFB); 4 mi [6.4 km] SE of summit of Mount Head, *Bird 28833* in 1972 (UAC); 2.5 km NE of Exshaw, *Brunton and Brunton 1247* in 1976 (DFB,DAO,ALTA,CAN); 2 km NE of Exshaw, *Brunton and Grant 1522* in 1977 (DFB,CAN); 2.5 km W of Exshaw, *Brunton 1530* in 1978 (DFB); 4.5 km W of Exshaw at Gap Lake, *Brunton 1528* in 1978 (DFB,DAO); 1 km NE of Exshaw, *Brunton and Coneybeare 1532* in 1978 (DFB,CAN); 2.5 km S of Kananaskis Environmental Sciences Center, Barrier Lake, *Brunton 1538* in 1978 (DFB); 12 mi [19.3 km] S of Seebe, *Cody, Jaques and Corbin 23037* in 1977 (DAO); southeast Barrier Lake, Kananaskis Valley, *Brunton 1623* in 1979 (DAO).

The species is exceptionally abundant at several sites, particularly the Grotto Mountain and Gap Lake sites (*Porsild 18147* and *Brunton 1289*, and *Brunton 1528* respectively). Alberta specimens are typically less than 20 cm tall. Only at the above sites (and at Barrier Lake, *Cody et al. 23037*) were plants noted which approached 30 cm in height, a condition more typical of eastern Canadian plants. This is likely a reflection of the much drier climate of Alberta. We observed that *P. atropurpurea* in drier-than-normal sites in Quebec were smaller than the typical.

Alberta *P. atropurpurea* is found on dry steep exposed, heavily-fractured limestone rock slopes or cliffs. With one exception (Heart Mountain, *Bird 18500*), the stations exhibited a southwestern exposure. Individual plants were partially shaded by rock ledges and/or scattered woody vegetation, usually *Ribes oxycanthoides* and/or *Potentilla fruticosa*. The plants grow out from under a sheltering ledge or boulder and are found only in those crevices in which a considerable amount of soil and/or plant debris has accumulated. The site preference was very consistent with other Canadian site descriptions (Brunton and Lafontaine 1974). The maximum elevation noted for any station of *P. atropurpurea* was 1650 m above sea level.

In almost every case, the Woolly Lip-fern (*Cheilanthes feei*) was a close (and frequently abundant) associate. These warmer-than-normal sites were also typified by a number of montane species which are very local in distribution in Alberta. They include Douglas Fir (*Pseudotsuga menzieii*), Limber Pine (*Pinus flexilis*), and Rocky Mountain Juniper (*Juniperus scopulorum* — possibly *J. scopulorum* × *Juniperus* sp.).

Purple Cliff-brake, being the largest and easiest to collect of Alberta *Pellaea*, is probably represented in herbaria in greater than natural frequency *vis.* other *Pellaea*.

Pellaea suksdorfiana (Smooth Cliff-brake) (Figures 3, 4).

This species occurs in Canada only in the Cordilleran region of British Columbia and Alberta, where it is considered to be uncommon and local (Taylor 1970; Rigby and Britton 1970). Prior to this study, it was known from five locations in Alberta. Twenty additional stations are listed below:

Spray Falls, Banff N.P., *Warren* in 1934 (ALTA); 3 mi [4.8 km] W of the Kananaskis Forest Experiment Station, *Porsild and Lid 19424* in 1956 (CAN); 5 mi [8.1 km] S of Kananaskis Forest Experiment Station, *Porsild and Lid 19424* in 1956 (CAN); E of Corral Creek, De Smet Range, Jasper N.P., *Porsild 21285* in 1959 (CAN); Talbot Lake, Jasper N.P., *Porsild 22377* in 1960 (CAN); Bearspaw Dam, Calgary, *A. Bird* in 1965 (UAC), *Brunton 1534* in 1978 (DFB); entrance near Hinton, *Pegg 2095* in 1965 (CAN,ALTA); southwest side Lac des Arc, Bow Valley, *Brunton 1139* in 1976 (DFB); W of Barrier Pass, *Jaques 5059* in 1974 (UAC), *Brunton 1293* in 1976 (DAO,DFB); E of Jasper, Jasper N.P., *Ogilvie* in 1960 (UAC); west side Heart Mountain 1.5 mi [2.4 km] SE of Exshaw, *Brunton 1308* in 1977 (DFB); 2.5 km W of Exshaw, *Brunton and Paton 1337, 1338* in 1977 (DFB), *Brunton 1531* in 1978 (DFB); 4.5 km W of Exshaw at Gap Lake, *Brunton 1529* in 1978 (DFB); 1 km NE of Exshaw, *Brunton and Coneybeare 1533* in 1978 (DFB); 12 mi [19.3 km] of Seebe, *Cody, Jaques and Corbin 23038* in 1976 (DAO).

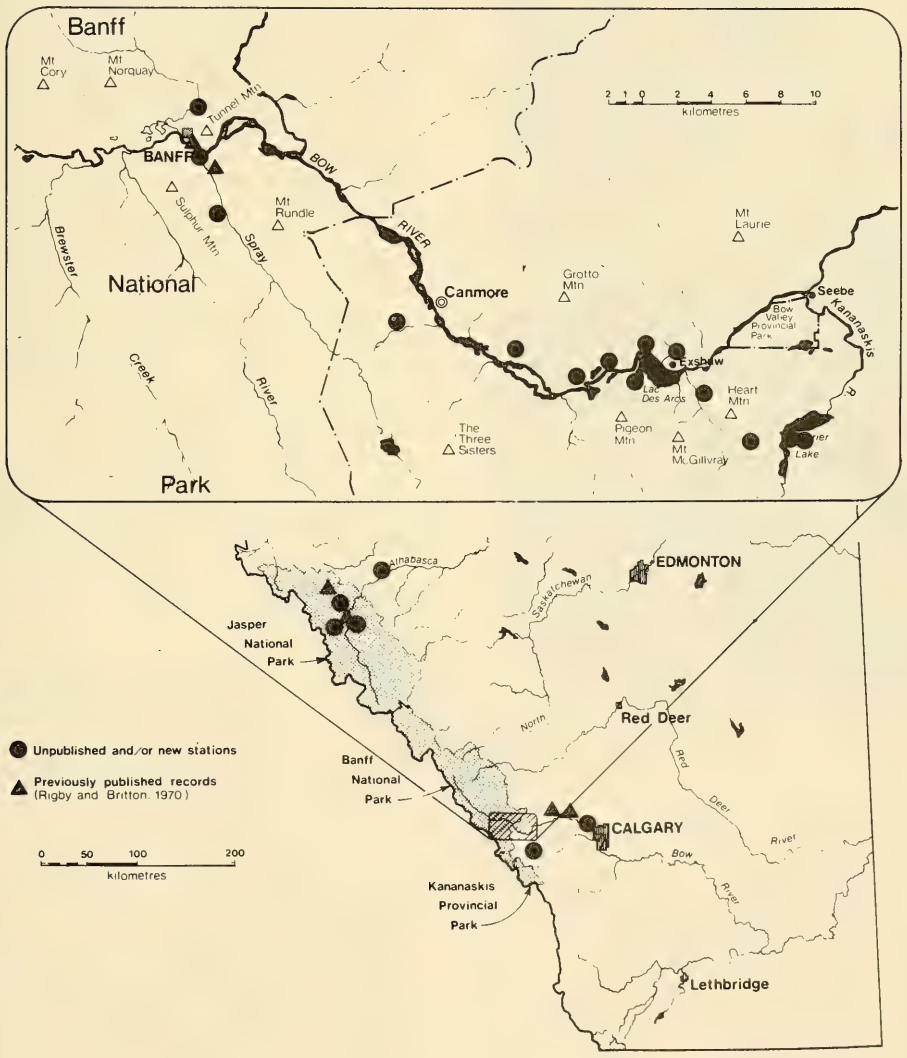

FIGURE 3. Distribution of *Pellaea suksdorfiana* in Alberta.

Sight Records: 6.5 km E of Canmore on Grotto Mountain (Brunton 1977); north side Banff Airfield, Banff N.P. (Brunton 1978); south side Tunnel Mountain, Banff N.P. (Brunton 1978); west side Hwy 40 at Barrier Lake (Brunton 1978); east side Hwy 40 at Barrier Lake (Brunton 1978).

Virtually all of these stations are from cliffs of limestone. All but two of the stations near Exshaw (*Brunton 1529* and *Brunton and Coneybeare 1533*) and one by Barrier Lake (*Jacques 5059*, *Brunton 1293*) are adjacent to water bodies. These latter stations are on north- or northeast-facing slopes.

FIGURE 4. Typical frond of *Pellaea suksdorfiana* growing out from fissure in southeast-facing limestone cliff-face. Gap Lake, Exshaw, Alberta, 18 February 1978.

Pellaea suksdorfiana prefers cool heavily-shaded, less arid sites than the other Alberta *Pellaeas*, normally selecting waterside sites with an eastern exposure. It often grows in thin fissures in open rock. Rarely exceeding 15 cm in height (and usually smaller) it is, nonetheless, typically larger than *P. occidentalis*. In those sites which are south-facing (e.g., *Brunton and Paton 1338*) there is heavy shade from surrounding trees. Individual clumps are open and sprawling, with fronds extending well out from the rock-face.

Pellaea suksdorfiana is uncommon throughout the Rocky Mountains of Alberta. It extends out onto the prairie in two sites (near Cochrane and Calgary).

For a morphological comparison of this species with *P. occidentalis* see Table 1.

Pellaea occidentalis (E. Nels.) Butters (Western Cliff-brake) (Figures 5, 6).

This is a species of the dry interior plains and low mountains of central North America. It is not found W of Alberta or E of Manitoba in Canada (Rigby and Britton 1970; Taylor 1970; Tryon 1957). Only in Wyoming does it extend across the Continental Divide into areas of moister climate (Hitchcock et al. 1969). It has the most exclusive range of any Canadian *Pellaea*, overlapping with others only in southwestern Alberta. Prior to this study it was known from three locations in Alberta. Fourteen additional stations are listed below:

Southwest slope Sawback Range, Banff N.P., *Porsild and Breitung 15482* in 1946 (CAN); southern slope Mount Cory, Banff N.P., *Porsild 17993* in 1951 (CAN); Kootenay Plains W of Nordegg, *Dumais* in 1976 (ALTA,DFB); Grotto Mountain, 6.5 km E of Canmore, *Brunton 1290* in 1976 (DFB,DAO); southeast end Mount Rundle, Canmore, *Brunton and Paton 1328* in 1977 (DFB,DAO); north side Barrier Lake, *Cody, Jaques and Cordin 23043* in 1976 (DAO); north side Crowsnest Lake, Crowsnest Pass, *Brunton 1613* in 1978 (DFB,DAO).

Sight Records: 2.5 km NE of Exshaw (Brunton 1976); 2 km NE of Exshaw (Brunton 1977); 4.5 km W of Exshaw at Gap Lake (Brunton 1978); south side Stoney Squaw Mountain, Banff N.P. (Brunton 1978); southwest side Mount Norquay, Banff N.P. (H. F. Coneybeare 1978); north side Banff Airfield, Banff N.P. (Brunton 1978); 2.5 km W of Exshaw (Brunton 1978).

Western Cliff-brake is the smallest Canadian *Pellaea*, rarely exceeding 10 cm in height. The Alberta stations are on exposed hot limestone cliffs and rock slopes with a southern or southwestern exposure. In every station examined, *Cheilanthes feei* was a close associate. It is typically found on the most exposed cliffs and rock areas. It is locally very abundant in the Bow Valley. The well-known Tunnel Mountain station in Banff National Park supports hundreds of thousands, if not millions, of plants. It is the largest site known to date.

This species grows in very dense clumps in a "pin-cushion" shape out of pocks and/or fissures in the rock face. The fronds rarely extend out beyond the surface of the rock face (as a water conservation measure?). Despite the fact that it grows close to the British Columbia border in Banff National Park and

the Crowsnest Pass, there are no records for this species W of the Continental Divide in Canada. The increase in precipitation on the west side of the divide is dramatic and appears to create unsuitable conditions for *P. occidentalis*, even on sites which seem to be otherwise quite suitable.

Outside of the Bow Valley, the Western Cliff-brake is rare in Alberta. Being very inconspicuous, however, it may well have been overlooked. It should be watched for elsewhere in dry valleys along the eastern slopes of the Rocky Mountains and on cliff areas in the prairie (e.g., the Milk River canyon).

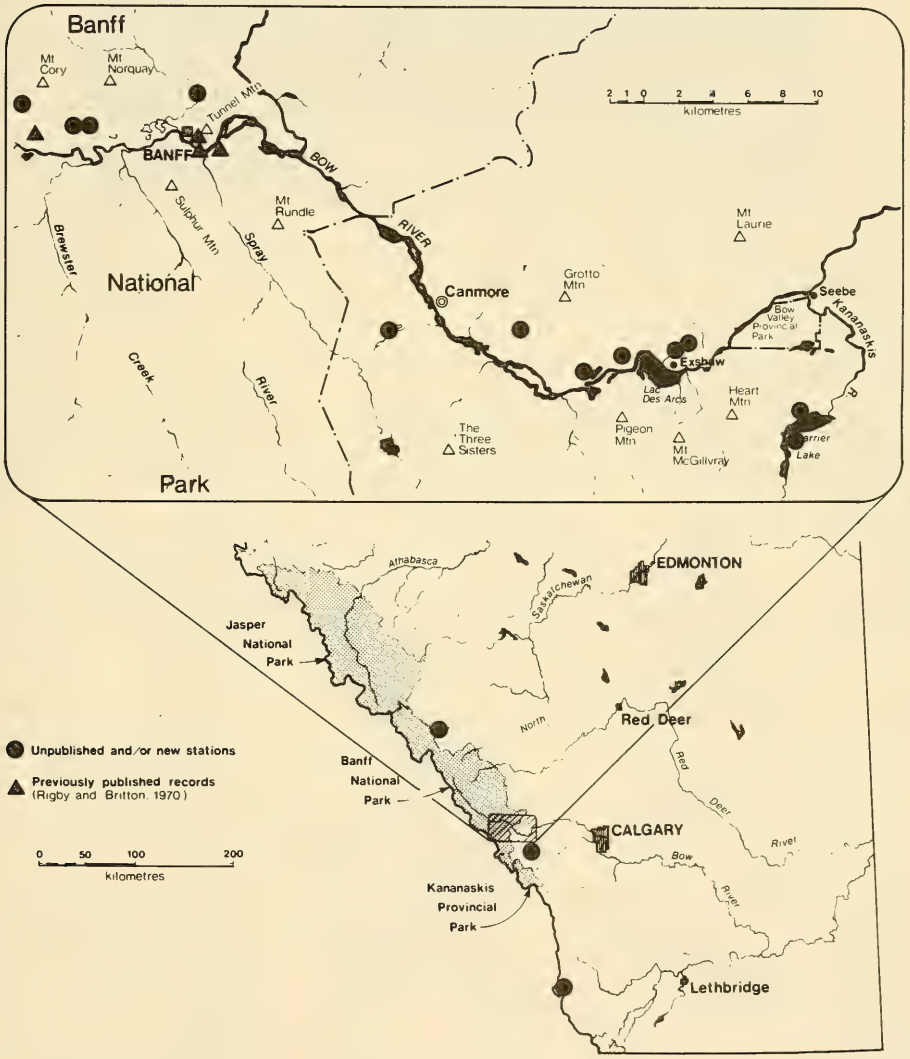

FIGURE 5. Distribution of *Pellaea occidentalis* in Alberta.

FIGURE 6. Typically dense clump of *Pellaea occidentalis* growing in hair-line fissure in open, south-facing limestone rock face. South (5 km) of Canmore Alberta, 1 November 1977.

TABLE 1—Comparison of characteristics of *Pellaea atropurpurea, P. occidentalis*, and *P. suksdorfiana*. Source: 1, Rigby and Britton (1970); 2, Tryon (1957); 3, This study

Characteristics	*P. occidentalis*	*P. suksdorfiana*	*P. atropurpurea*	Source
Chromosome no.	$2n = 58$	$2n = 116$	$2n = 87$	1
No. of spores per sporangium	64 (small)	32 (large)	32 (large)	1,2
Frond length	Maximum 15 cm	Maximum 20 cm	Maximum 35 cm	1,3
Frond displacement*	Dense, thickly clumped "pin cushions" flush with rock face	Open and spreading, extending out beyond rock face	Erect and spreading, extending up and outward from ledges far beyond rock face	1,3
Rachis color*	Golden to dark brown	Reddish-brown to brown-purple	Purple to blackish-purple	1,3
Stipes*	Thin and brittle old stipes inconspicuous	Thicker and sturdy, rarely sparsely pubescent, old stipes conspicuous and often silvery color	Thick and sturdy, heavily pubescent old stipes abundant, silvery color	3
Pinnae*	Mitten-shaped and sessile; margins strongly reflexed	Oblong-lanceolate and (at least lower) petioled; margins strongly reflexed	Lanceolate to oblong-lanceolate and petioled; margins slightly reflexed	1,2,3
Pinnae angle to rachis	Perpendicular	Acute	Broad	2,3
Site preference*	Dry exposed SW-facing limestone	Shaded cool, E-or N-facing calcareous cliffs by water	Dry partially-shaded, SW-facing limestone	3

*Feature of particular value for field identification.

Discussion

There are many more stations for *Pellaea* in Alberta than was previously thought. It is a common group on the limestone cliffs and rock faces of the Bow Valley in western Alberta. It is reasonable to expect that more stations will be found in other drier mountain valleys along the eastern slopes of the Rocky Mountains.

Pellaea suksdorfiana is the most frequently observed Cliff-brake in Alberta, occurring uncommonly in cooler shaded, more moist cliffs. *Pellaea atropurpurea* appears to be locally common on sites similar to that for *P. occidentalis*, both preferring hot dry open limestone cliffs and rock faces. *Pellaea atropurpurea* prefers a more shaded and more heavily fractured rock than does *P. occidentalis*.

With three of the four Canadian species occurring in Alberta, the *Pellaea* flora of the province is particularly rich. With so many stations growing in close association in the Bow Valley, there is an excellent opportunity to study the ecology of these ferns and to search for (as yet unknown) hybrids. As Tryon (1957) suggests that *P. suksdorfiana* may have arisen as a fertile hybrid between *P. atropurpurea* and *P. occidentalis*, this becomes an interesting possibility.

Acknowledgments

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Characteristics of Peregrine Falcons Migrating through Central Alberta, 1969–1978

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In central Alberta from 1969 to 1978, 541 sightings of migrating Peregrine Falcons (*Falco peregrinus*) were recorded in spring, and 34 in fall. Exclusion of suspected duplications gave 226 spring migrants and 27 fall migrants. In spring, adults arrived an average of 9 d before the immatures. The great majority (86%) of spring migrants passed through the study area between 4 May and 23 May. Presence of adults peaked from 4 May to 7 May, of immatures from 12 May to 15 May. Fall sightings occurred from 10 September to 4 October. In spring, males comprised 33% of the adult sample and 35% of the immatures identified. Aggression between the sexes is suggested as a reason for the observed imbalance in the sex ratio. The proportion of adults to immatures in spring was 1 to 1. Spring migrants that were seen to leave the study area in a northerly direction did so by soaring and high-altitude sailing. Strong head winds did not appear to deter some adults from migrating. Foraging activity was seen to take place throughout the day and as late as 1 h after sundown.

Key Words: Peregrine Falcon, *Falco peregrinus*, migrations, Alberta.

Fall migration of northern Peregrine Falcons has been studied along the coastal and Great Lakes flyways (e.g., Hunt et al. 1975; Mueller and Berger 1961; Ward and Berry 1972), but very little information has been recorded about their spring migration. Isolated spring sightings of peregrines have been reported from across the continent, as evidenced by scattered notes in *American Birds*. During a spring study of migrating raptors along Lake Ontario only four peregrines were seen in 108 d (Haugh and Cade 1966).

The paucity of data has led to speculation about the routes, timing, and age structure of the peregrines moving north. The fact that few subadults have been observed on the breeding grounds suggested that mortality of first-year birds is high. Cade (1960) postulated that some immature peregrines may not return to the Arctic and Subarctic until their second year.

This paper provides information on the timing of spring and fall migrations of peregrines through Alberta, and the age, sex, and behavior of these migrants.

Study Area and Methods

The study area is a crescent-shaped strip of land situated on the rolling plains of central Alberta and is roughly 15 × 2 km. Bordered by a marshy lake, it is dominated by grain fields and pastures which hold scattered pockets of Trembling Aspen (*Populus tremuloides*) and willow (*Salix* spp.). Shallow depressions collect melt-water in spring, attracting ducks and shorebirds in large numbers during that season.

The study area was regularly visited from late winter to late autumn to observe the hunting habits of raptorial birds. During the 47-d period 15 April to 31 May, visits to the area averaged 27.9 d in each of the 10 yr. During the 45-d period from 1 September to 15 October visits averaged 14.4 d. Days afield varied, some lasting from sunrise until nightfall and others spanning only 3 or 4 h during the afternoon or morning. Actual hours afield in spring were tabulated only in the last 5 yr (Table 1).

In searching for peregrines, no set procedures were followed. Vehicular travel in the study area was limited, especially during wet periods. Most points were accessible only on foot, and 5–25 km were covered by hiking each day.

Resting peregrines were detected by scanning the landscape through 10-power binoculars. In calm weather, the falcons sat on posts or stones and were readily found, but strong winds induced them to shelter on the ground. Very rarely were trees used as perches. As a rule, to avoid flushing them, resting peregrines were not approached closely. No attempts at trapping or photography were made. Most falcons were watched until they left of their own accord.

The majority of sightings were of flying peregrines. To maximize chances of seeing hunting falcons, I stayed near points where foraging peregrines had previously been observed. Alarm reactions of prey species, especially shorebirds, usually signalled the appearance of a falcon. Often, while I was quietly sitting in the open or in a parked car, the falcons seemed to ignore my presence and approached boldly, providing numerous close-range views. As the various age and sex groups differ in appearance, and some

birds show individual differences in plumage and behavior, individuals sometimes could be recognized with certainty; this helped me to minimize duplicate counts.

The following procedure was used to reduce possible duplications. When a bird identifiable as to age and sex, for instance an immature female, was observed on several consecutive days, each observation was recorded for the maximum count, but only one sighting of an immature female was included in the minimum count, unless there was evidence of more than one immature female falcon present in the study area. Sightings of unidentified peregrines were included in the maximum count even though sex and age were unknown, but not in the minimum count if a classified peregrine was known to be present in the study area at the time.

Two or more interacting falcons were seen frequently in aggressive encounters or in what appeared to be cooperative hunting. Whenever this happened, I could assess their numbers more accurately.

The passage of peregrines, like that of other migratory birds, is seldom an evenly-spaced phenomenon. There were periods when none were seen in the study area, followed by days or parts of days when several appeared in rapid succession. The rate of arrival and departure influenced my ability to calculate the number of individual peregrines seen passing through the study area. I believe that the true number is considerably less than the maximum count presented but somewhat higher than the minimum figure.

Results and Discussion

Numbers Sighted

Peregrines were sighted from 16 April to 30 May (Figure 1) and again from 10 September to 4 October (Figure 2). From 1969 to 1978, 541 peregrine sightings were recorded in spring (Table 1), and 34 in fall (Table 2). These include duplicate counts except the most obvious ones. The minimum counts pooled for 10 yr are 226 in spring (Table 1) and 27 in autumn (Table 2). From 1976 to 1978 both maximum and minimum spring counts were much higher than average, which can be attributed only partly to an increase in field time (Table 1). These years were characterized by early springs and low meltwater levels, with few ponds available to ducks and waders, which instead concentrated on the marshy lakeshore bordering the study area. In consequence the falcons hunted over a relatively narrow strip of land and were more readily observed than in wet springs when they foraged over much of the surrounding countryside.

Timing of Migrations

The earliest dates on which peregrines were sighted in the study area in different years varied from 16 April to 9 May. These early arriving falcons were always adults. The mean date of first arrivals was 27 April. First dates for the brown-backed immatures varied from 27 April to 10 May. The mean first arrival date for immatures was 5 May, 9 d behind the adults.

The last spring dates on which adults were seen in the study area ranged from 11 May to 27 May with a mean last date of 19 May. Comparable dates for immatures varied from 21 May to 30 May with a mean of 25 May, 6 d after the adults. The great majority of peregrines (86%) passed through the area from 4 May to 23 May. Daily sightings showed a peak on 13 and 14 May. The peak of adult sightings occurred between 4 and 7 May, 8 d before the peak of immatures which fell between 12 and 15 May (Figure 1).

The limited data from the autumn show sightings from 10 September to 4 October with a peak on 23 September (Figure 2).

Subspecies and Plumage Variation

White (1968) recognized three subspecies of Peregrine Falcons in North America. *Falco p. anatum* formerly nested in nearly all suitable habitat south of the tundra except the northwest Pacific coast where *F. p. pealei* occurs. *Falco p. tundrius* inhabits the Arctic and Subarctic. During this study no representatives of *F. p. pealei* were identified. Most of the migrants seen could not be assigned to any subspecies. A few falcons that appeared typical, in some respects, of *F. p. anatum* were seen during the early part of each spring season, while typical examples of *F. p. tundrius* were among the last peregrines to pass through. The criterion used for field identification of the two subspecies was dorsal coloration which could best be appraised when the bird was in flight. The blue-gray color of adult *F. p. anatum* was lightest on the rump and darkened to nearly black on the head, tail, and wingtips. This variegated color pattern of *F. p. anatum* was also noted by Beebe (1974). When in flight, typical *F. p. tundrius* adults appeared evenly blue-gray on the entire dorsal surface. They usually looked smaller and slenderer than typical *F. p. anatum* birds of the same sex.

All adult falcons that could be observed through a 20-power scope at reasonably close range showed a very light, unmarked upper breast. Occasionally there was a pinkish wash on the remainder of the ventral surface. Dark barring and spotting on the belly and flanks varied from bold to fine, and from dense to widely spaced. Greater diversity of pigmentation and wider extremes in light and dark types were found among the first-year birds. Few spring immatures were streaked on the entire undersurface as they are in the preceding autumn. The majority showed a varying amount of unmarked yellowish-white on the breast, which made them resemble adults. To describe these falcons properly, a good view of the dorsal color

TABLE 1 Observation days, average daily hours afield, and numbers of peregrines sighted during the period 15 April to 31 May, 1969–1978. Maximum sightings include duplications. In the minimum sightings all suspected duplications are deleted

Year	Days	Daily hours	Maximum sightings	Adult	Immature	Unidentified	Minimum sightings	Adult males	Adult females	Immature males	Immature females	Unidentified
1969	22		20	5	10	5	12	1	3	3	3	2
1970	25		15	7	4	4	9	1	4	1	2	1
1971	27		33	7	11	15	14	5	2	4	3	–
1972	25		26	13	8	5	14	5	3	–	3	3
1973	23		41	20	15	6	21	3	10	4	4	–
1974	26	9.5	46	11	28	7	16	2	4	3	7	–
1975	29	9.8	41	23	10	8	31	2	19	3	7	–
1976	30	10.2	66	20	29	17	44	3	8	9	14	10
1977	38	9.9	163	26	91	46	33	5	5	7	11	5
1978	34	10.5	90	35	33	22	32	6	9	2	12	3
Totals	279		541	167	239	135	226	33	67	36	66	24

TABLE 2—Observation days and numbers of peregrines recorded during the period 1 September to 15 October, 1969–1978. Maximum sightings include duplications. In the minimum sightings all suspected duplications have been deleted

Year	Days	Maximum sightings	Minimum sightings	Adult males	Adult females	Immature males	Immature females	Unidentified
1969	10	1	1	1	—	—	—	—
1970	13	3	2	—	1	—	1	—
1971	13	1	1	—	—	1	—	—
1972	12	3	3	—	2	—	—	1
1973	15	4	3	—	1	—	1	1
1974	13	—	—	—	—	—	—	—
1975	18	1	1	—	—	1	—	—
1976	16	8	8	—	1	—	3	4
1977	18	7	4	—	—	1	2	1
1978	16	6	4	—	—	2	2	—
Totals	144	34	27	1	5	5	9	7

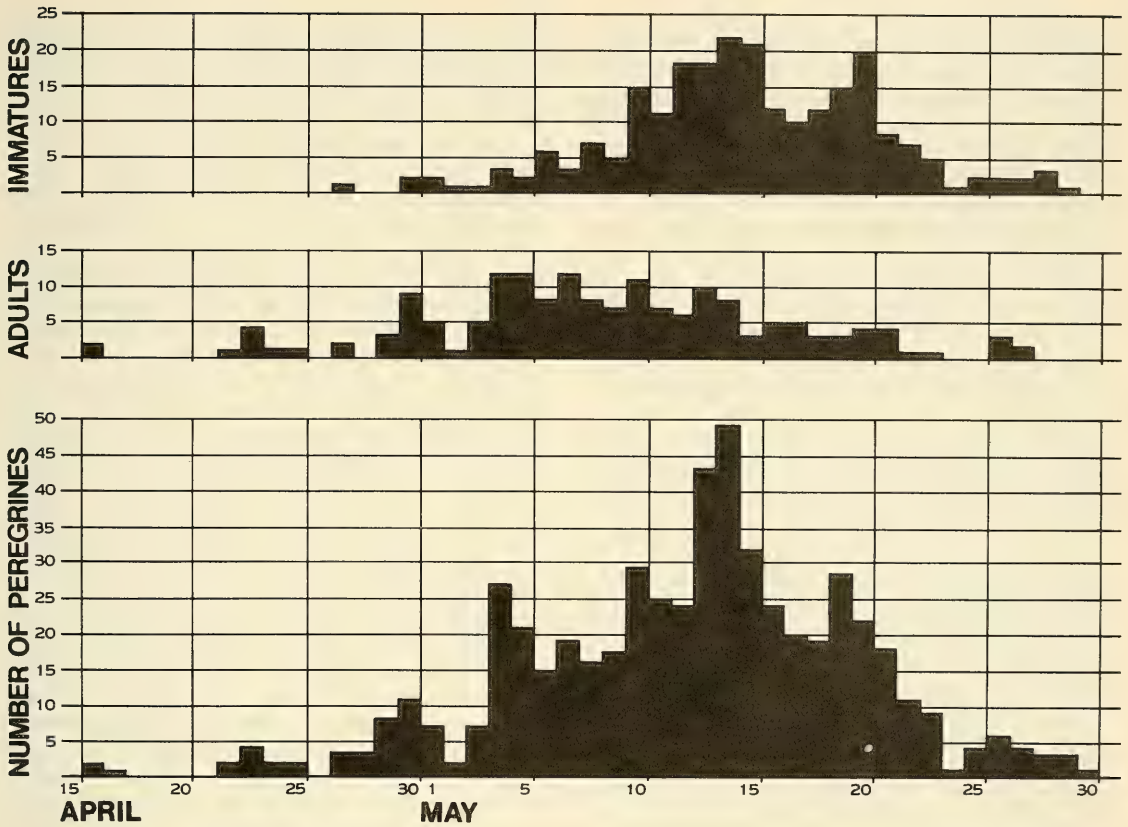

FIGURE 1. Maximum numbers of peregrines sighted in spring. Data pooled for 10 years, 1969–1978.

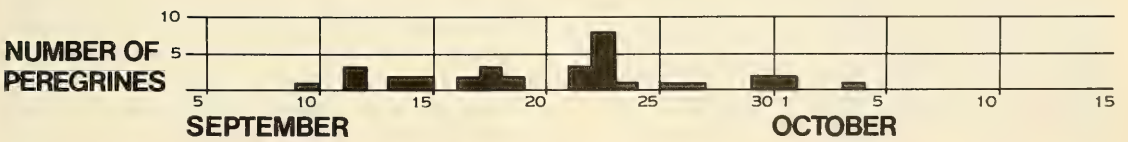

FIGURE 2. Maximum numbers of peregrines sighted in autumn. Data pooled for 10 years, 1969–1978.

had to be obtained. Their brown backs ranged in tone from blackish-brown to sandy. The pale brown *F. p. tundrius* immatures were easily mistaken for Prairie Falcons (*Falco mexicanus*), which were only rarely seen in the study area during spring and fall. In fall, second-year peregrines had attained adult coloration although their wings and backs retained some brownish feathers.

Of interest was the occurrence in the study area of "red-tailed" peregrines. About one-third of the adults showed a buffy or brownish cast on the upper tail. Also some immature falcons had "red" tails. The color varied from dark reddish brown to a strikingly pale buffy-orange. To my knowledge, there are no records in the literature of such "red-tailed" peregrines.

Age Ratios

During 10 springs, 102 immature peregrines were recorded among a total of 202 falcons classified as to age. This age ratio cannot be considered representative of the population as a whole. Shor (1970, p. 56) reported that peregrine populations contain more adults than first-year individuals "even at the time of the fall migration." This difference should be even more pronounced in spring, as Enderson (1969) calculated a 70% mortality among first-year birds from band returns.

The very small sample of fall data obtained included 14 immatures and 6 adults. Fall counts from coastal migration routes indicate immature to adult ratios of 4 to 1 and 6 to 1 (Berry 1971; Ward and Berry 1972; Hunt et al. 1975). These ratios suggest differential migratory behavior among the age classes. Berry (1971) argued that adults, being more experienced in foraging, could fly directly to their wintering grounds.

My observations suggest that during spring both age classes hunt the same prey and in a similar way. Hunting success ratios of adults and of immature falcons migrating through central Alberta during spring are not significantly different (Dekker, unpublished data). Hence, the observed prominence of first-year young in central Alberta in spring cannot be explained as a consequence of different hunting ability as suggested by Berry (1971) for fall migrants. The majority of peregrines known to linger in the study area, however, were in immature plumage. The duplication rate of immatures was 2.3 (102 to 239), that of adults was 1.6 (100 to 167). It appeared that adult peregrines on their way north through central Alberta were less inclined to tarry on attractive feeding grounds than the immature birds.

Sex Ratios

The smallest male peregrines are about two-thirds the size of the largest females (Godfrey 1966). Hunt et al. (1975), however, have recognized the difficulty of accurately estimating sex ratios on the basis of sightings. I agree that the size of a peregrine cannot be judged reliably while the bird is resting unless it can be compared to another bird. In flight, however, a male peregrine usually appears slenderer than a female. Small to average-sized males and large to average-sized females are readily distinguished when seen in flight by an experienced observer. Additionally, foraging habits may provide clues and assist in classification. For example, males are more given than females to pursue and swoop repeatedly at fleeing sandpipers. About 85% of the peregrines included in the minimum count and classified to sex were observed under conditions that allowed me to make such classification with confidence. An element of doubt is present in about 15% of cases when individual variation in size made the sexes look alike. Rather than assigning these puzzling birds to the unidentified category, I classified them on the basis of impressions. As only one observer was involved these impressions may be expected to show a degree of consistency. Sex ratios obtained for adult (33%) and immature peregrines (35%) in fact show a striking similarity.

Adult males are reported to be most elusive along the fall migration routes. Only eight out of 639 peregrines trapped on Assateague Island from 1939 to 1971 were identified as adult males (Ward and Berry 1972). No adult males were among 250 peregrines captured on the Texas beaches from 1952 to 1973 (Hunt et al. 1975), and only one among 20 classified in fall in this study. Percentages of immature male peregrines trapped along the major fall migration routes along the Texas and Maryland coasts respectively were reported as 23.4% (Hunt et al. 1975) and 30% (Ward and Berry 1972).

Hunt et al. (1975) claim that there is no obvious reason why immature sex ratios should be unbalanced. The observed preponderance of females in the Texas survey may reflect differential trap-response and/or foraging habits. The males are believed to be able to exploit inland populations of small birds better than are the larger females, and are less often seen on the beaches. In my opinion, aggression between sexes may force the smaller males away from localities where female peregrines congregate. I frequently saw females chase males. Males were observed to carry their prey long distances before alighting to eat it. Two were observed to soar to great altitudes and feed while on the wing. By contrast, females routinely consumed their prey at the site of capture. On two occasions an adult female was seen to rob an immature male of his freshly caught prey. Attempts at stealing each other's prey were seen also between immature females and between immature and adult females.

Weather and Daily Routine

The influence of weather on the movements of migrating raptors in spring and fall has been discussed in detail by Mueller and Berger (1961) and Haugh and Cade (1966). They concluded that the majority of raptorial birds migrate when tail winds are blowing. Ward and Berry (1972) and Hunt et al. (1975) correlated highest numbers of peregrines in fall with days of heavy cloud, light tail winds, and low temperatures. Those conditions usually accompanied the influx of some falcons into my study area in fall as well as in spring. The birds were easily located then as they rested on exposed perches (fence posts) or hunted at low elevations. Mueller and Berger (1961) have remarked that hawks have rarely been observed in the process of departing on migration. During this study many resting falcons were watched until they flew away of their own accord. In spring they consistently left the study area in a north-northwest direction. Such departures were seldom noticed on days of heavy cloud and low temperatures.

Of particular interest was the observation that light to moderate head winds at ground level did not prevent some falcons from departing. They did not migrate close to the ground, as stated by Fischer (1967), but maintained high altitudes attained by soaring. Brown and Amadon (1968, p. 65) write that "falcons usually fly rather than sail or soar" while migrating. Both migrating and foraging falcons observed in this study not only soared during optimum conditions of sun and wind, but also on windy days when skies were cloudy, and even when light rain was falling. When nearly straight overhead of an observer, some of these soaring falcons were just visible in 10-power binoculars. On two occasions soaring peregrines were seen to enter the cumulus clouds that top thermal currents.

Falcons that were seen to leave the study area on a steady northerly course on spring days when head winds were blowing, habitually winged upwind for a short distance before beginning to soar. During their circling ascent the falcons drifted downwind until they flexed their wings and glided through the wind rapidly. Even head winds gusting to 50 km per hour at ground level did not deter them from high-altitude travel. All falcons observed to migrate during these contrary airflows were adults. First-year falcons that were seen to travel northward did so when tail winds were blowing or when head winds were only light. Most observed departures of adults and immatures took place during mid-morning after the air had warmed sufficiently to allow the formation of rising air currents.

During the remainder of the day some migrating peregrines were located when they descended to attack prey species such as feeding shorebirds. After consuming a kill, a peregrine would resume flight by soaring to great heights and sailing away on slightly flexed wings. Such interruption and resumption of daytime migratory travel was observed from 11:00 to 18:00 hours. In spring, during the late afternoon and early evening, falcons sometimes flew in from a southerly direction as if they were just arriving. After a rest, these falcons began hunting in the hour preceding sundown. Several immature falcons were seen chasing and capturing shorebirds shortly before dusk. One immature female falcon that had been watched from late afternoon to nightfall began attacking ducks that flew inland from the lake one hour after sundown. Through binoculars, the birds were just visible, silhouetted against a cloudless sky. Crepuscular hunting was also observed by Beebe (1960), Clunie (1976), Fischer (1967), and Rudebeck (1950-1951). Late foraging activity may explain the relative scarcity of falcons on the Texas beach at sundown, which prompted Enderson (1965) to speculate on the likelihood of nocturnal migrations.

During this study, several falcons were observed roosting at nightfall. They were sitting on posts surrounded by water or on shoreline rocks. Of three adult peregrines that were seen roosting at night only one was still on its post when it was checked at sunrise. It remained there until 10:00 hours when it flew upwind, began to soar and sailed northward.

I have seldom found evidence of hunting at dawn. An hour after sunrise was the usual start of foraging flights. When a large food item such as a duck was captured, the falcon would eat for about 45 min and rest until mid-morning. A second meal of the prey remains was frequently taken before the falcon flew away, soared to great height, and glided northwards until lost to view. Some spring migrants that soared and sailed northwards during mid-morning were seen to stoop at prey species that flew below them; it appeared that these peregrines did their foraging along the way.

NOTE: Formerly the study area was part of the summer range of peregrines that nested along rivers to the south and west about 100 km away. By 1969, at the start of this survey, that central Albertan population of *F. p. anatum* was all but extirpated (Dekker 1967). In 1977 and 1978 one or two peregrines frequented the area during the summer months. In 1978 a first-year male, recognizable by his banded feet, damaged tail, and lack of shyness, was often seen from April to late August. These birds were believed to have originated from the captive breeding program sponsored by the Canadian Wildlife Service and the Provincial Fish and Wildlife Division. All known and suspected sightings of these birds have been eliminated from the tabulations in this paper.

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Notes

Extralimital Record of a Narwhal (*Monodon monoceros*) in Hall's Bay, Newfoundland

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Key Words: Narwhal, *Monodon monoceros*, Newfoundland, sighting, range, geographical distribution, pack ice.

On 1 March 1978 a Narwhal (*Monodon monoceros*) was seen from a small boat in Hall's Bay, Newfoundland (49°30′N, 56°00′W). Pack ice, several miles wide, had jammed across the head of the fjord and extended into the bay so that the animal, along with four Humpback Whales (*Megaptera novaeangliae*), was confined to an area 8 × 4 km. Humpback Whales were observed in the area earlier in the winter, but the Narwhal was not seen until February. Both local and arctic ice conditions were unstable within the bay, but the entrance to the bay remained blocked so that the Humpback Whales and the Narwhal were unable to leave Hall's Bay until 6 April. At this time the pack ice, loosened several days earlier by an ice-breaker, drifted to open water enabling the whales to escape. No sightings of the Narwhal or Humpback Whales were made after they left Hall's Bay although repeated air surveillance was attempted (Cyril Pelly, Springdale, Newfoundland, personal communication).

Hall's Bay contains 1 m of fresh water at the surface which results in rapid formation of local ice over the entire bay. During the period the whales were confined to the bay the area of open water decreased irregularly. For a period of 3 wk the only open water was 1.6 km NW of Mansfield Head, which varied in size from 120 × 45 m. This confinement allowed for close observation and photography of the Narwhal (Figure 1).

The Narwhal was a dark gray color, 2–3 m long with a tusk of approximately 15–20 cm, indicating that it was a male. Generally the Narwhal surfaced in the open water during periods the Humpback Whales were below the surface. In addition to such time-sharing behavior, spatial separation was maintained, as the Humpback Whales typically would follow the edges of the open water while the Narwhal restricted its surface activities to the center. Although ice forced the Narwhal into proximity with human observers, it remained timid throughout its confinement typically maximizing its distance from observers. Food species including Atlantic Herring (*Clupea harengus*), Rainbow Smelt (*Osmerus mordax*), and Capelin (*Mallotus villosus*) were plentiful in the area and hydrophone recordings indicated hunting activity by the animal (Ford and Fisher 1978). No surface sounds were heard from the Narwhal.

The range of the Narwhal in the Canadian Eastern Arctic extends south to about 66°N (Banfield 1974). Our sighting was approximately 1800 km south of this at 49°30′N. Our report is the second sighting of a Narwhal in Newfoundland in the last decade. The first extralimital record of a mature male Narwhal, found washed on a beach in White Bay in 1969, was reported by Mercer (1973). Several sightings of white whales reported in Newfoundland waters (Sergeant and Fisher 1957; L. M. Tuck, St. John's Newfoundland, personal communication), could be either Belugas (*Delphinapterus leucas*) or Narwhals. The south-eastward movement of arctic ice in the late winter brings Harp (*Phoca groenlandicas*) and Hooded (*Cystophora cristata*) Seals in large numbers to Newfoundland's coast. Occasionally Bearded Seals (*Erignathus barbatus*), Ringed Seals (*Phoca hispida*), Walrus (*Odobenus rosmarus*), and Polar Bears (*Ursus maritimus*) have drifted south with the ice (L. M. Tuck, personal communication).

Narwhals are reported to winter in the Baffin Bay area (Mansfield et al. 1975) and it is probable that, on occasion, they follow ice southward. This could account for the present record, but may not account for the June 1969 record (Mercer 1973) unless that animal came with the ice and survived in Newfoundland through the spring. Because it is possible to mistake the finless dorsum of an immature Narwhal for that of a seal, it may be that more Narwhals frequent the sparsely inhabited shores of Newfoundland than are being recognized.

We gratefully acknowledge the help of Francis Hull and Cyril Pelly of Springdale, Newfoundland, during the period of our work in Hall's Bay.

FIGURE 1. The Hall's Bay Narwhal during the last week of its confinement. The tusk length was approximately 45 cm, which aged the animal at over 2 yr. Photographed by Duncan Findlayson.

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First Canadian Record of the Black Buffalo (Osteichthyes: Catostomidae)

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Crossman, E. J. and S. J. Nepszy. 1979. First Canadian record of the Black Buffalo (Osteichthyes: Catostomidae). Canadian Field-Naturalist 93(3): 304–305.

Ictiobus niger was captured in the Canadian waters of Lake Erie on 20 June 1978.

Key Words: Black Buffalo, *Ictiobus niger,* first Canadian record, Lake Erie, geographical distribution.

A specimen of *Ictiobus niger,* the Black Buffalo, one of the larger deep-bodied suckers, was captured in the Canadian waters of Lake Erie on 20 June 1978. It had been taken in a commercial trap net set by F.W.

TABLE 1—Comparison of characters in the three species of *Ictiobus*

Character	*Ictiobus cyprinellus*	*Ictiobus bubalus*	*Ictiobus niger*
Body	Robust, slightly compressed, back not highly elevated	Deeper and narrower than *I.n.*, highly elevated, mid dorsal ridge sharper than others	More slender, but thicker than *I. b.*, less elevated and less sharpened than *I. b.*
Dorsal rays	Usually 24–28	Usually 27–30	Usually 30
Mouth	Large, oblique	Smaller, less oblique than *I. c.*, more inferior than *I.n.*	Less oblique than *I. c.*, larger and less inferior than *I. b.*
Lips	Thinner than others, only faintly striate, upper about level with lower margin of orbit	Thicker, more or less coarsely straite, upper far below lower margin of orbit	Thicker than *I.c.*, more or less coarsely striate, upper far below lower margin of orbit
Distance mandibular symph. to tip of maxilla		Only slightly greater than diam. of orbit in adults	As much as twice diam. of orbit in adults
Upper jaw	About as long as snout	Distinctly shorter than snout	Shorter than snout
Gill rakers post. face first arch	Nearly 100	Fewer than 60	Fewer than 60
Lower pharyngeal arch	Thin, more than twice as high as wide, teeth weak	Heavy, about as wide as high, teeth strong	Heavy, about as wide as high, teeth strong

Krause and Sons Fisheries, Leamington, Ontario, in Pigeon Bay, west of Point Pelee (41°56′50″N, 82°31′40″W). The specimen was turned over to Nepszy at the Ontario Ministry of Natural Resources Research Station Wheatley, Ontario, and forwarded to Royal Ontario Museum, frozen, as an unidentified sucker, possibly *I. cyprinellus*. After fixation in formalin, and preservation in ethyl alcohol the buffalo was 630 mm in total length, and weighed 3.56 kg.

Preliminary examination, including cranial fontinelles, clarified that it was *Ictiobus* but that it was not *I. cyprinellus*, the commonest species and the only species previously reported as occurring in Canada.

Morphologically it seemed to resemble both *I. bubalus* and *I. niger* and was somewhat suggestive of a hybrid. Neither of those species, however, is common in Lake Erie and published characteristics used to separate the two species are difficult to interpret.

Ictiobus niger is basically a species of the Mississippi River system and occurs from the Ohio River and its tributaries south to Mexico. It has, however, been said to be native to southern Lake Michigan (Hubbs and Lagler 1964) and therefore in the Great Lakes system. Moore (1968) listed *I. niger* but not *I. bubalus* from Lake Erie, and Hubbs and Lagler (1964) specified earlier that there was one report only of *I. niger*, and gave no Great Lakes record for *I. bubalus*. Trautman (1957) gave no records for the Ohio waters of Lake Erie for either species. Trautman did indicate, however (under *I. bubalus*), that specimens had been caught in Sandusky Bay, Lake Erie, which had been identified as hybrids between *I. cyprinellus* and *I. bubalus* or *I. niger*.

So few specimens of *Ictiobus* other than *I. cyprinellus* are seen from the Great Lakes that the characteristic features of larger specimens of *I. bubalus* and *I. niger* are poorly known. A comparison of the features of the three species is given in Table 1. The supposed hybrids may have represented the presence of *I. bubalus* or *I. niger* in Lake Erie in the past.

After detailed examination of the characteristics, including the cranial bones, of this specimen, G. R. Smith and R. M. Bailey of the Museum of Zoology, University of Michigan confirmed that the specimen represents *Ictiobus niger*. Therefore the specimen is not only a recent corroboration of the occurrence of the species in Lake Erie but also represents a species new to the fauna of Canada. It has been added to the collection of the Royal Ontario Museum (ROM 34562).

We once more thank Rudy Krause for his vigilance and for turning over specimens suggestive of something new. We thank Erling Holm, and G. R. Smith and R. M. Bailey for their help in the identification of the specimen.

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Thaspium trifoliatum (Meadow-parsnip) in Canada

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Ball, P. W. 1979. *Thaspium trifoliatum* (Meadow-parsnip) in Canada. Canadian Field-Naturalist 93(3): 306–307.

Thaspium trifoliatum (Meadow-parsnip) is reported from a locality near Amherstburg, Essex County, southern Ontario. Although reported from Canada on a number of previous occasions, all the earlier records appear to be based on confusion with the very similar *Zizia aptera*. The differences between *T. trifoliatum* and *Z. aptera* are discussed and it is noted that, in addition to the fruit characters usually used to distinguish between them, the width of the petiole also appears to be diagnostic.

Key Words: *Thaspium trifoliatum*, Umbelliferae (Apiaceae), Essex County, Ontario.

Thaspium trifoliatum (Meadow-parsnip) has been recorded from Canada on a number of occasions. Indeed, Macoun (1883) states that the species is abundant in the prairie provinces. Subsequent investigations have shown that all of these records are erroneous. For example, Scoggan (1957) makes it quite clear that all Manitoba records of *T. trifoliatum* should be referred to *Zizia aptera*. Soper (1949) lists *T. trifoliatum* from southern Ontario, this record apparently being based on a specimen from Caradoc, Middlesex County, collected by J. Dearness in 1891, and now in the herbarium of the Biosystematics Research Institute, Ottawa (DAO). This specimen was subsequently redetermined by W. J. Cody as *Z. aptera*, and, although the specimen is immature, it does appear to be this species. Boivin (1967) did not include *T. trifoliatum* in the Canadian flora and, in a personal communication, has stated that he has not traced any reliable records since then.

The discovery of a location for *T. trifoliatum* in southern Ontario seems therefore to be the first authentic record for this species in Canada. The locality is a woodlot about 3 km E of Amherstberg in Essex County. The dominant trees were *Quercus alba* (White Oak), *Ostrya virginiana* (Hophornbeam), *Carya ovata* (Shagbark Hickory), and *Fraxinus pennsylvanica* (Green Ash). The shrub layer was fairly dense with *Zanthoxylum americanum* (Prickly Ash), *Rhus aromatica* (Fragrant Sumach), *Viburnum rafinesquianum,* and *Crategus* spp. (hawthorn) prominent in the vicinity of the *Thaspium*. The stand also contained *Geum vernum*, another species that is rare in Ontario and largely restricted to Essex County. The population of *T. trifoliatum* consisted of over 50 individuals so does not appear to be in immediate danger of extinction; however, any major disturbance of the woodlot could seriously jeopardize the survival of this species in Canada.

Thaspium trifoliatum and *Z. aptera* are remarkably similar in appearance, so that confusion between these two species is not surprising. When in fruit they can be readily distinguished by two characters. *Zizia aptera* has fruits with narrow ridges (Figure 1A) and the central fruit of each subumbel is sessile; *T. trifoliatum* has fruits which are distinctly winged (Figure 1B) and which are all distinctly pedicelled. Unfortunately these differences cannot be easily observed when the plants are in flower. The wings on the fruits of *T. trifoliatum* are not apparent until a fairly late stage in fruit development. The presence of a central sessile flower in each subumbel can be readily observed once all the flowers are open, but when the inner flowers of each subumbel are in bud it is difficult to determine whether the central flower is sessile or pedicelled. An additional character which is useful, although not completely reliable, is the width of the petiole of the cauline leaves (Figure 1C, D). In *Z. aptera* the petioles of the lower leaves on the flowering stem are 8–16 mm wide and almost form a sheath around the stem, whereas in *T. trifoliatum* the petioles of the lower leaves are 4–8 mm wide and scarcely enclose the stem except at the node. The petioles of the upper leaves of both species are somewhat narrower, 5–10 mm wide in *Z. aptera* and 3–5 mm wide in *T. trifoliatum,* but if leaves are compared from similar regions of the stem then the petioles of *Z. aptera* are always wider than those of *T. trifoliatum*.

Thaspium trifoliatum is variable in flower color. Var. *trifoliatum,* which is the predominant variety in the Appalachian region, and which also occurs rarely elsewhere, has purple flowers. Var. *flavum*, which has yellow flowers, is more western in distribution occurring as far west as Minnesota, Arkansas, and Kansas, but it also occurs rarely in the east. The Ontario material is referable to var. *flavum*.

Specimen Examined

Essex County. 3 km (2 mi) E of Amherstberg. 10 June 1975. P. W. Ball 14475 (TRTE, DAO) (Flower, young fruit). Anderdon Township 3 km (2 mi) NE of Amherstberg on east side of Concession II. 26 May 1977. P. M. Catling (TRT) (Flower). June 1977. P. M. Catling (TRT, TRTE, CAN). (Fruit).

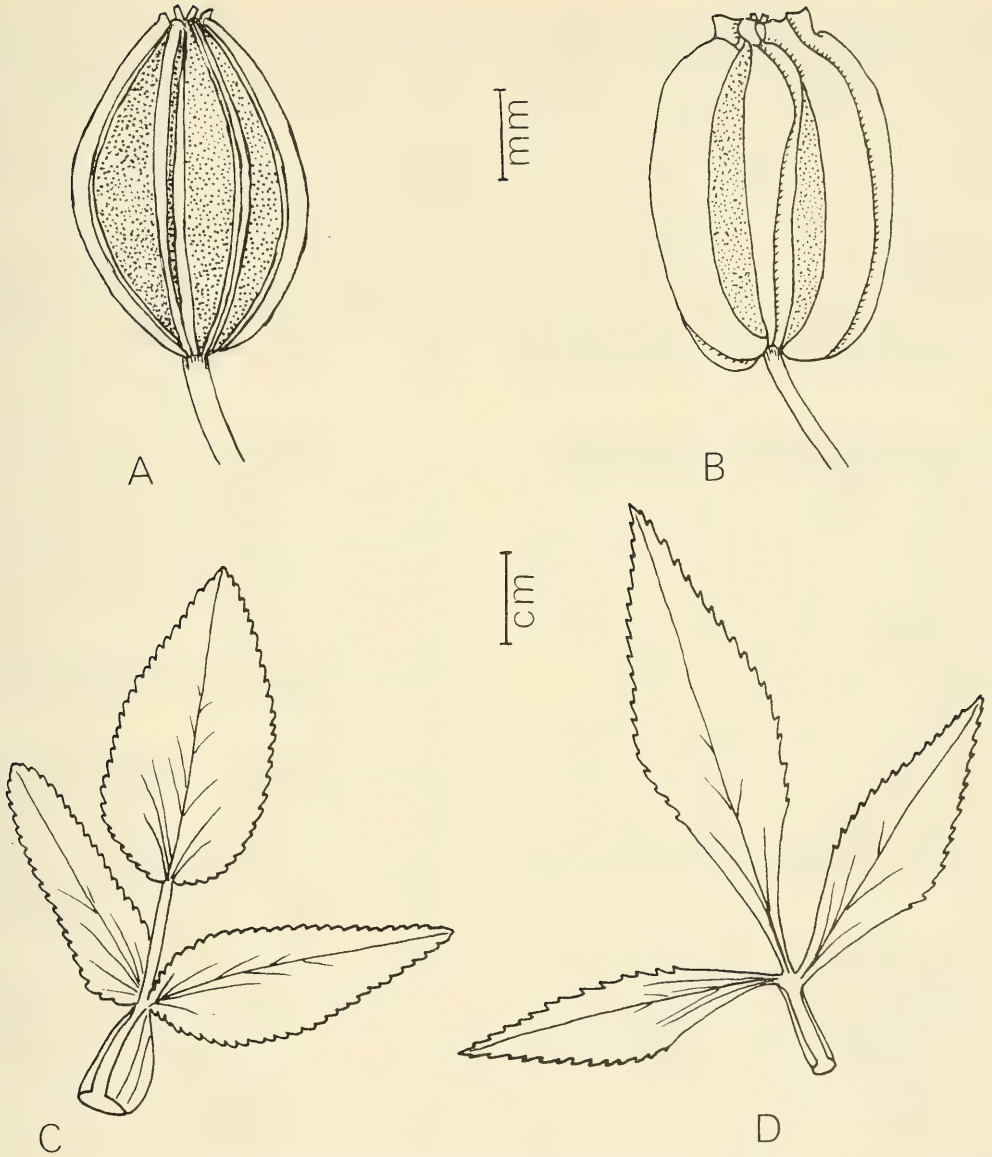

FIGURE 1. Fruit and upper leaves of *Zizia aptera* (A, C) and *Thaspium trifoliatum* (B, D).

Acknowledgments

My thanks to J. McNeill for checking the identity of some of the specimens and to P. Catling for collecting some specimens in fruit. This work was supported by National Research Council of Canada Grant A6494.

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Largest Gray Wolf Skulls Found in Alberta

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Gunson, J. R. and R. M. Nowak. 1979. Largest Gray Wolf skulls found in Alberta. Canadian Field-Naturalist 93(3): 308–309.

Measurements of greatest length and zygomatic width of five large skulls of *Canis lupus* from Alberta are reported. Three, all from the range of *C. l. occidentalis,* are larger than the previous largest specimen, also *occidentalis.*

Key Words: Gray Wolf, skull measurements, *Canis lupus,* size.

According to Goldman (1944) the largest subspecies of the Gray Wolf (*Canis lupus*) are found in Alaska and northwestern Canada. With respect to measurements in millimetres of greatest length (g.l.) and zygomatic width (z.w.) of skull, the four largest individuals that he listed (pp. 490–497), all males, were the following: United States National Museum 9001, *C. l. occidentalis,* Fort Simpson, Mackenzie, g.l. 292.8, z.w. 156.5; Royal Ontario Museum 33-9-20-5, *C. l. pambasileus*, White River, Yukon, g.l. 293.7, z.w. 151.5; Royal Ontario Museum 31-2-16-2, *C. l. pambasileus,* White River, Yukon, g.l. 292.8, z.w. 149.0; University of California Museum of Vertebrate Zoology 31043, *C. l. columbianus,* Iskut Summit, British Columbia, g.l. 288.9, z.w. 155.0. On the basis of both measurements, the specimen from Fort Simpson, which was collected in 1869, has been until now the largest reported skull of a North American Gray Wolf.

Several specimens of male *C. lupus* recently collected in Alberta have skull dimensions that approximate or surpass those of the above-mentioned material (Table 1). The largest of all, number Z78.104.1 in the collection of the Provincial Museum of Alberta (formerly 66-18 of the Alberta Fish and Wildlife Division), was taken at Roche Lake in the Swan Hills area, about 155 km northwest of Edmonton. Two others, Z78.104.2 and Z78.104.3, taken during 1972–1974 in northwestern Alberta were also larger than the Fort Simpson wolf. All three were taken in areas within the original range of *C. l. occidentalis,* as was Z78.104.4. Specimen Z78.104.5 was collected in southwestern Alberta from an area within Goldman's original range of *C. l. irremotus.* Determination of the taxonomic position of that specimen and others recently collected from even more southerly locations in Alberta awaits the collection of additional data.

Several extensive regional collections of North American Gray Wolves have been assembled in recent decades, but with the exception of the Alberta Fish and Wildlife Division collection (12 measurements on each of 468 skulls), none have been thoroughly analyzed. One of us (Nowak) made cursory examinations of a collection from western Canada in the possession of the University of British Columbia and a collection from Alaska in the possession of the University of Alaska. No skulls were found that surpassed in size the larger of the above-described specimens, but one of the Alaska skulls of *C. l. pambasileus* may be the largest ever recorded for that state. The specimen (University of Alaska 40682) was

TABLE 1—Specifics of five large male *Canis lupus* from Alberta, Canada. PMA = Provincial Museum of Alberta; AFW = Alberta Fish and Wildlife Division

Specimen no.		Location	Date of collection	Greatest length (mm)	Zygomatic width (mm)
PMA	AFW				
Z78.104.1	66–18	54°46′N,114°55′W	30 Jan. 1966	304.5	154.8
Z78.104.2	V441036	55° 4′N,119°50′W	13 Feb. 1973	297.6	158.0
Z78.104.3	V441097	54°43′N,113°17′W	Feb. 1974	288.8	162.5
Z78.104.4	V441057	54°48′N,119°20′W	27 Feb. 1973	292.6	155.8
Z78.104.5	V441016	51°27′N,114°50′W	28 Feb. 1973	285.3	160.4

collected in 1966 in the Wood River drainage of central Alaska, and its measurements (taken to the nearest millimetre) are g.l. 292, z.w. 153.

Mean greatest length and zygomatic width for 83 adult male *C. lupus* taken in Alberta during 1965–1966 to 1977–1978 were 275.6 (range 251.3 to 304.5) and 150.7 (range 128.6 to 162.5). The following data on series of North American wolf skulls (Nowak 1973) are offered for purposes of comparison: 233 Recent male *C. lupus* from throughout northern and western North America, mean g.l. 259.6 (range 235–293), mean z.w. 141.1 (range 126–164); 20 male *C. l. pambasileus,* mean g.l. 271.4 (range 248–288), mean z.w. 145.4 (range 130–154); 62 *C. dirus* (unsexed) from late Pleistocene deposits at Rancho La Brea, California, mean g.l. 294.8 (range 258–316), mean z.w. 163.3 (range 148–177). In comparisons of skull dimensions of wolves from several areas in western North America, Skeel and Carbyn (1977) recorded largest mean g.l. and z.w. in specimens from Prince Albert National Park, Saskatchewan, within the range of *C. l. occidentalis* (Goldman 1944) or *C. l. griseoalbus* (Hall and Kelson 1959).

Although there is no comprehensive analysis of specimens throughout North America, the wolves of the boreal-subalpine forest regions of Alberta and adjacent areas appear to be the largest of the North American Gray Wolves.

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Aquatic Feeding by a Woodchuck[1]

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Fraser, D. 1979. Aquatic feeding by a Woodchuck. Canadian Field-Naturalist 93(3): 309–310.

A Woodchuck (*Marmota monax*) was seen eating aquatic plants which it obtained by climbing on fallen trees on a lakeshore. An attraction to sodium-rich plants probably accounts for the behavior.

Key Words: Woodchuck, *Marmota monax,* aquatic plants, sodium, feeding behavior.

Although they feed on a variety of vegetation, Woodchucks (*Marmota monax*) are not generally known to eat aquatic plants. The following observations document such behavior.

On 30 June 1978, while canoeing on a small unnamed lake in Sibley Provincial Park, Ontario (48°27′N, 88°45′W), I watched through binoculars as an adult Woodchuck climbed among the tangled branches of fallen Eastern White Cedar trees (*Thuja occidentalis*) overhanging the water. The animal climbed to a location 1 to 2 m from shore where it clung, holding its head 1 to 3 cm above the surface of the water and its hindquarters slightly higher. Prominent light areas visible around the nipples indicated that it was a female. From this location the Woodchuck dipped its left front paw into the water and pulled vegetation into its mouth. It fed for about 1 min, then returned to shore, apparently because my canoe had drifted within 10 m of the location.

The Woodchuck returned to the water's edge about 8 min later, and walked about 1 m from shore along a half sunken log. There it stopped and chewed on three plants which it dipped from the water with a front paw. It then climbed to two sites among the fallen trees, eating submersed and floating-leafed vegetation at each location. The animal left to shore 16 min after it had reappeared.

The feeding sites were dominated by submersed *Hippuris vulgaris* and *Potamogeton zosteriformis,* floating-leafed *Nuphar variegatum,* and emergent *Sagittaria* sp., growing in 30 cm of water over a soft organic bottom. At the main feeding location were 10 *H. vulgaris* plants missing their upper portions, one uprooted specimen and one damaged fragment of

[1]Ontario Ministry of Natural Resources, Wildlife Research Section Contribution No. 78-22.

P. zosteriformis, four leaf fragments and two leafless petioles of *N. variegatum,* and three damaged *Sagittaria.* The second feeding site by the log had damaged fragments of *P. zosteriformis, N. variegatum,* and *Sagittaria.* It appeared that the animal had completely consumed the portions of *H. vulgaris* which it had picked, but left partially chewed fragments of the other species.

I revisited the site five times in the next 18 days. On the last day, 18 July, freshly damaged *H. vulgaris, N. variegatum,* and *Sagittaria* were observed. Fresh damage was not evident on the earlier visits.

Like many herbivores, Woodchucks show evidence of a sodium-specific hunger in the spring and early summer (Weeks and Kirkpatrick 1978), and aquatic plants are generally far richer in sodium than are terrestrial ones (Jordan et al. 1973). This may explain why a Woodchuck would make such an effort to obtain a small quantity of vegetation. Non-aquatic herbage was readily available on the forest floor, lakeshore, and roadsides nearby.

Nonetheless, this behavior is clearly a rarity, since few Woodchucks would be expected to find convenient access to aquatic plants in shallow water, and the animals are rarely seen swimming (Grizzell 1955). Hamilton (1934) does, however, list one sighting of a Woodchuck eating *Vallisneria americana* in July in an Adirondack Mountain pond. This animal also reached the vegetation by walking on a fallen log.

I am grateful to D. R. Voigt, M. C. Smith, and H. P. Weeks for offering suggestions on an earlier draft of the manuscript.

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Dispersion of Freshwater Leeches (Hirudinoidea) to Anticosti Island, Quebec

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Davies, Ronald W. 1979. Dispersion of freshwater leeches (Hirudinoidea) to Anticosti Island, Quebec. Canadian Field-Naturalist 93(3): 310–313.

Four species of freshwater leeches, *Helobdella stagnalis, H. triserialis, Glossiphonia complanata,* and *Mooreobdella fervida* are reported from Anticosti Island. Evidence is present to show that these species dispersed to Anticosti Island passively by sea currents from Quebec North Shore of the Gulf of St. Lawrence.

Key Words: dispersion, leeches, Hirudinoidea, Anticosti Island, water currents.

Anticosti Island in the Gulf of St. Lawrence is about 216 km long with a maximum width of 48 km. It is separated by the 29-km or more wide Jacques Cartier Passage (Détroit de Jacques Cartier) from the North Shore of the province of Quebec to the north-east, and by the 64-km or more wide Gaspé Passage (Détroit d'Honguedo) from the Gaspé Peninsula to the south-west (Figure 1). Having been entirely covered by ice during the Wisconsin glacial period (Stockwell 1957) and without known glacial refugia or landbridges to the mainland during or since the ice recession (Bleakney 1958; Cameron 1958), the fauna of Anticosti Island provides an ideal location to interpret postglacial migrations and dispersal.

Although Verrill (1863), a prolific author of papers on leeches (Hirudinoidea), made no reference to freshwater leeches on Anticosti Island it cannot be assumed that none were present at that time. Subsequently Schmitt (1904) recorded the presence of *Dina* (= *Mooreobdella*) *fervida* and Johansen (1924) recorded *Helobdella stagnalis.* In a general review of the geographical distribution of freshwater leeches of Canada, Davies (1973) reconfirmed the presence of *M. fervida* and *H. stagnalis* on Anticosti Island and

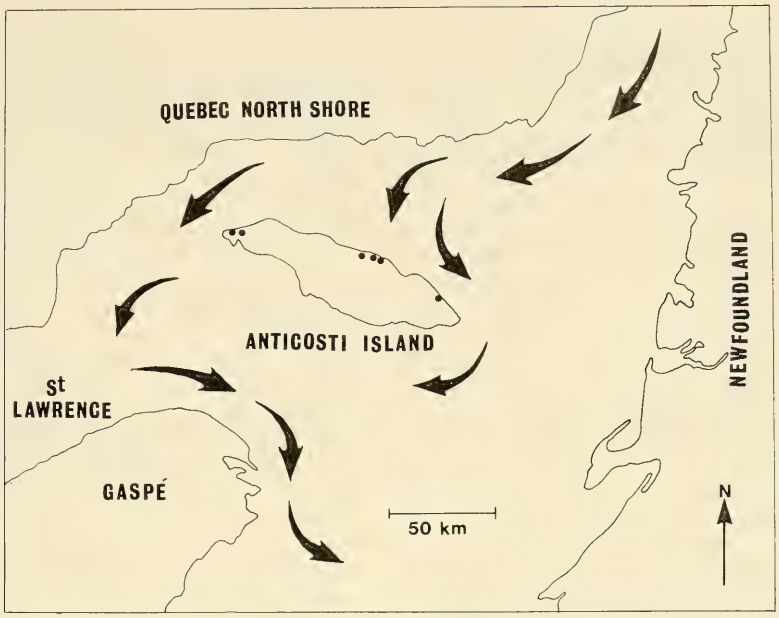

FIGURE 1. Map of south-eastern Quebec and Newfoundland showing the major currents (based on Cameron 1958) and the collection sites of the freshwater leeches (•).

added records for *Helobdella triserialis* and *Glossiphonia complanata*. Davies (1973) recorded seven species from the Gaspé Peninsula to which, from subsequent collections, can now be added *Nephelopsis obscura* and *Percymoorensis marmorata* (Table 1). Although no new species can be added to the 18 recorded in Quebec by Davies (1973) (Table 1) the presence on the Quebec North Shore of *H. stagnalis, H. triserialis, G. complanata, M. fervida, N. obscura, Erpobdella punctata,* and *Dina parva* can be confirmed.

Three of the four leech species on Anticosti Island (*H. stagnalis, H. triseralis,* and *G. complanata*) belong to the family Glossiphoniidae while *M. fervida* belongs to the family Erpobdellidae. The Glossiphoniidae produce thin-walled cocoons which are immediately covered by the parents' body and to which, while still enclosed within the egg membrane, the young glossiphoniids develop an embryonic attachment. As young glossiphoniids prematurely removed from the parent fail to survive, it can be assumed for these three species at least, that dispersion to Anticosti Island must have been in the adult stage. The Erpobdellidae deposit their cocoons on a firm substratum and the parent has no further participation. It is thus possible for *M. fervida* to be dispersed in the cocoon stage while attached to stones or plant material.

TABLE 1—The distribution of freshwater Hirudinoidea species in the province of Quebec, Gaspé Peninsula, Anticosti Island, and the Quebec North Shore

Species	Quebec	Gaspé	Anticosti	North Shore
Piscicola geometra (Linn.)	X			
Piscicola milneri (Verrill)	X			
Piscicola punctata (Verrill)	X			
Bactracobdella picta (Verrill)	X	X		
Glossiphonia complanata (Linn.)	X	X	X	X
Glossiphonia heteroclita (Linn.)	X	X		
Helobdella stagnalis (Linn.)	X		X	X
Helobdella triserialis (Blanchard)	X	X	X	X
Placobdella ornata (Verrill)	X			
Placobdella phalera (Graf)	X			
Dina parva (Moore)	X	X		X
Erpobdella punctata (Linn.)	X			
Mooreobdella fervida (Verrill)	X	X	X	X
Nephelopsis obscura (Verrill)	X	X		X
Bdellerogatis plumbeus (Moore)	X			
Macrobdella decora (Say)	X			
Mollibdella grandis (Verrill)	X			
Percymoorensis marmorata (Say)	X	X		

The occurrence of four species of freshwater leeches on Anticosti Island requires explanation, and there are three possible hypotheses: (*a*) passive dispersal by animals, wind, or currents; (*b*) introduction by man; (*c*) active dispersion.

Because of the absence of *H. stagnalis* from the Gaspé Peninsula, the leech fauna of Anticosti Island shows greater similarity to that of the Quebec North Shore. The absence of a species record from an area is sometimes a reflection of the degree of collection intensity, but as there have been more collections from the Gaspé than from either Anticosti Island or the Quebec North Shore, the absence of *H. stagnalis* from the Gaspé appears to be real. All the leech records from Anticosti Island are from the north-east Quebec North Shore-facing coast (Figure 1), supporting the supposition of the Quebec North Shore as the source of dispersion. Indeed, of the 17 sites sampled on Anticosti Island (Davies 1973), three of the four sites on the north-east coast contained leeches but none of 13 on the southern half of the island did.

All four leech species on Anticosti Island are eurytopic (Davies 1973) benthic feeders, lack jaws, and are very sensitive to disturbances in the water. Thus although passive dispersal by birds has been recorded for benthic leeches (Daborn 1976) it hardly seems credible that a bird traversing Jacques Cartier Passage would not occasionally land on the southern half of this narrow island. Similarly if leeches or cocoons were transported by strong winds, hurricanes, or tornados to Anticosti Island they would be expected on both halves of the island. As passive dispersal by wind can probably be discounted, dispersal by currents or tides remains a possibility.

In a study of the osmoregulatory ability of freshwater leeches, Reynoldson and Davies (1976) showed that *H. stagnalis* was able to maintain itself hyperosmotically in media between 47 and 112.7 mosmol/L and was a conformer at higher media concentrations, and thus could survive periods of immersion in sea water. Unfortunately the osmoregulatory abilities of *H. triserialis, G. complanata,* and *M. fervida* have not been studied but if they prove to be at least as good as that of *H. stagnalis*, it is clear that all four species could survive the sea passage to Anticosti Island.

Nephelopsis obscura, a widely distributed species in Canada (Davies 1973), present on the Quebec North Shore but absent from Anticosti Island can only maintain itself hyperosmotically between 15.6 and 59.5 mosmol/L (Reynoldson and Davies 1976) with a correspondingly low survival rate in salt water.

Ball and Fernando (1970) concluded on the basis of the dissimilarities between the freshwater triclad faunae of Anticosti Island, Gaspé, and the Quebec North Shore, and the similarity on Anticosti Island of the triclad distribution and amphibian introductions to the island by man in 1899 (Johansen 1924) that triclads were also introduced to Anticosti Island by man. As the triclads and amphibian introductions are located in the southern half of Anticosti Island, however, the restriction of leeches to the northern half strongly negates the probability of man having introduced leeches to Anticosti Island.

Active directional dispersion has been recorded for *Percymoorensis marmorata* in Quebec (Richardson 1942) and for *Erpobdella punctata* in Michigan (Sawyer 1970). But as neither species is recorded from the Quebec North Shore nor Anticosti Island and dispersion to Anticosti Island would require an initial downstream movement into the sea rather than the upstream movement recorded, active directional dispersion to Anticosti Island is improbable.

By elimination, the only probable mode of dispersion of leeches to Anticosti Island is passive dispersal by sea currents. For *H. stagnalis, H. triserialis,* and *G. complanata* the adults could either be attached to floating debris or free in the water, but for *M. fervida* the dispersive place could be either the cocoons or the adults. The theory of passive dispersion of leeches in sea currents to Anticosti Island from the Quebec North Shore is substantiated by examination of the predominant currents (Figure 1) which flow along the Quebec North Shore with a south-southeast orientation to the mouth of the St. Lawrence River and then along the Gaspé coast (Cameron 1958).

It thus appears that the freshwater leeches of Anticosti Island have reached the island from the Quebec North Shore rather than from the Gaspé passively through the action of sea currents. This is the first probable record of passive dispersion in sea currents for freshwater leeches.

The samples from Anticosti Island were collected by Ian Ball (then of the University of Waterloo) for my identification.

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Relative Efficiencies of Museum Special, Victor, and Holdfast Traps for Sampling Small Mammal Populations

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Small mammal populations in northern Ontario boreal forest were sampled with paired traps. Relative to Museum Specials, Victors captured proportionally fewer of most species, but Holdfasts captured more soricids, an equal number of cricetids, and fewer zapodids and sciurids. The most important factors determining the capture rate appeared to be the type of bait treadle in Museum Special–Victor pairs and trap size in Museum Special–Holdfast pairs. Significant differences in treadle sensitivity were not reflected in the catch.

Key Words: trap selection, trapping bias, small mammals.

When studying the demography of small mammal populations it is necessary to obtain relatively unbiased samples. This is often attempted with one, or more, of the several types of kill traps commercially available. Some types have been shown to be significantly more effective than others in capturing some species of small mammals (Pruitt and Lucier 1958; Neal and Cock 1969; Smith et al. 1971; Wiener and Smith 1972). Also the size of the trap has been shown to influence the mean weight of the catch (Neal and Cock 1969). Because body weight is often used as an estimate of age in small mammal studies, estimates of age structure of the population would also be biased. Therefore, the type of trap used may significantly influence the estimates of the abundance of the population, the age (weight) structure of the population, and the relative abundances of the various species in the community. The purpose of the present study was to determine which trap-related biases were present in the small mammal-forestry research being conducted by the Canadian Wildlife Service, Ontario Region.

Materials and Methods

Two extensively used small mammal kill traps are the Museum Special and the Victor mouse trap. The former measures 69 × 141 mm and has a 12 × 26 mm wood-covered bait treadle, while the latter measures 48 × 99 mm and has an 11 × 15 mm metal bait treadle. A third, occasionally used type is the Holdfast trap, which is the same size as the Victor but has the same triggering mechanism and treadle as the Museum Special. All three traps are manufactured by Woodstream Corporation, Niagara Falls, Ontario L2E 6T3, or Lititz, Pennsylvania 17543.

I compared the relative efficiencies of these three traps by sampling with a Museum Special and either a Victor or a Holdfast at each trapping point. Strings were attached to the traps so that they could be placed in likely capture locations within a 1-m radius of the trapping points, which were approximately 15 m apart and located either in a single line or in a grid. Any line or grid contained only one combination of traps. Traps were baited with a mixture of peanut butter, rolled oats, and rendered bacon fat, and were

checked on 3 consecutive days.

Trapping was conducted in 1976 and 1977 on a variety of uncut and clearcut boreal forest sites near Manitouwadge, Ontario (May to October), and on a series of uncut and strip-cut boreal forest sites near Beardmore, Ontario (September). A total of 12 324 trapnights was accumulated using Museum Special–Victor pairs and a total of 20 572 trapnights using Museum Special–Holdfast pairs (1 trap set for 1 night = 1 trapnight).

The sensitivity of the trap types was measured by determining the maximum weight, to the nearest gram, which could be placed on the distal part of the treadle and still allow the trap to be set. Fifty of each type of trap were tested after they had been used in the field for at least four rounds of normal trapping. The weights used were standard balance weights.

Results and Discussion

The average ($x \pm SE$) weight that could be carried on the distal end of the treadle without tripping the trap was 1.8 ± 0.08 g for Museum Special, 3.6 ± 0.18 g for Holdfast, and 7.0 ± 0.32 g for Victor traps, which reflects the relative sensitivities of the traps. The Holdfast held significantly ($P<0.001$) more weight than did the Museum Special, and the Victor held significantly ($P<0.001$) more weight than the Holdfast. The range in weights carried was also different between trap types, with the Victor showing the greatest range: Museum Special, 1–3 g; Holdfast, 2–6 g; Victor, 3–10 g.

For Museum Special–Victor pairs I compared the proportion of Victor-caught animals weighing less than 10 g, the maximum observed weight carried by a Victor, with the proportion weighing more than 10 g and found no significant differences (chi-square test) in those proportions for soricids ($P > 0.1$), cricetids and zapodids combined ($P > 0.9$), or all three groups combined ($P > 0.1$). For Museum Special–Holdfast pairs I compared the proportion of Holdfast-caught animals weighing less than 6 g, the maximum observed weight carried by a Holdfast, with the proportion weighing more than 6 g and found no significant difference in that proportion for soricids ($P > 0.1$), but found that the difference was significant for all three groups combined ($P < 0.001$). (All cricetids and zapodids captured weighed more than 6 g.) The Holdfasts therefore caught a greater proportion of animals weighing less than 6 g than did the Museum Specials. The significant differences in triggering weight were not reflected in the catch.

If triggering weight was not a factor, then the captures with Museum Special–Holdfast pairs would be influenced only by trap size, and captures with Museum Special–Victor pairs would be influenced by trap size and treadle composition. Table 1 shows that relative to Museum Specials, Holdfasts caught significantly more Masked Shrews (*Sorex cinereus*) and total soricids, and significantly fewer Meadow Jumping Mice (*Zapus hudsonius*) and Least Chipmunks (*Eutamias minimus*). Relative to Museum Specials, Victors caught significantly fewer Masked Shrews, total soricids, Deer Mice (*Peromyscus maniculatus*), Southern Red-backed Voles (*Clethrionomys gapperi*), Heather Voles (*Phenacomys intermedius*), Rock Voles (*Microtus chrotorrhinus*), total cricetids, and total small mammals. Eight of the nine other species showed a lower capture rate in Victors than in Museum Specials.

Trap size appears to be an important factor in determining the capture rate of three species in Museum Special–Holdfast pairs. Body size in relation to trap size may explain the high capture rates of Masked Shrews in Holdfasts, and Least Chipmunks in Museum Specials. If so, then treadle composition clearly outweighs trap size as a factor influencing the capture rate of Masked Shrews in Museum Special–Victor pairs.

Smith et al. (1971) and Wiener and Smith (1972) observed a similar difference in capture rate between Museum Specials and Victors, and suggested that Museum Specials were more efficient than Victors because of their more sensitive triggering mechanism. My data do not support that suggestion; rather, the type of bait treadle is indicated as the main factor influencing the difference in capture rate between Victors and Museum Specials. The influence may be due, at least in part, to the wood-covered bait treadle of the Museum Special which likely retains odors better than the metal Victor treadle.

There were no significant differences between trap type in mean body weight of any species captured in Museum Special–Holdfast pairs (Table 1). In Museum Special–Victor pairs, however, Southern Red-backed Voles and Meadow Jumping Mice caught in Museum Specials were significantly heavier than those caught in Victors. Differences in mean weight would be expected to be due to differences in triggering weight, but that does not appear to be the cause in my study.

There was no significant difference (chi-square test) in the proportions of species captured 10 or more times in Museum Specials and Victors ($P > 0.1$), but there was a significant difference between Museum Specials and Holdfasts ($P < 0.001$). That difference was not apparent within either soricids ($P > 0.9$) or cricetids ($P > 0.1$), suggesting that the difference was between taxonomic groups. When the proportions of total captures of soricids, cricetids, zapodids, and sciurids were compared, there was a significant difference (chi-square test) between Museum Specials and Holdfasts ($P < 0.001$) but not between Museum

TABLE 1—Numbers and mean weights (g) of small mammals trapped in Museum Special–Victor pairs (M–V) and Museum Special–Holdfast pairs (M–H), and the significance (chi-square test and t-test) of the differences within pairs. Sample sizes for weights approximate those given in the number columns, but in some cases are slightly smaller

Species	Museum Special–Victor				Museum Special–Holdfast			
	Number		Weight		Number		Weight	
	M	V	M	V	M	H	M	H
Sorex cinereus	71	41**	3.5	3.4	88	160***	3.5	3.6
Sorex palustris	2	0	15.8		0	1		14.1
Sorex arcticus	1	2	7.5	7.6	3	1	7.1	10.2
Microsorex hoyi	0	1		3.3	0	3		4.1
Blarina brevicauda	7	2	18.5	18.0	8	16	19.9	18.6
Total soricid captures	81	46**			99	181***		
Peromyscus maniculatus	176	67***	15.4	15.4	267	235	16.2	15.8
Clethrionomys gapperi	240	142***	20.8	19.6*	196	196	21.3	20.4
Phenacomys intermedius	28	10**	21.0	24.5	36	27	19.7	23.2
Synaptomys cooperi	2	0	24.4		1	3	24.3	19.9
Microtus pennsylvanicus	14	11	24.4	23.6	17	21	25.4	24.0
Microtus chrotorrhinus	25	12*	23.5	22.4	6	11	24.2	21.5
Total cricetid captures	485	242***			523	493		
Zapus hudsonius	6	2	12.2	9.2*	5	0*	14.9	
Napaeozapus insignis	2	0	21.4		0	2		28.3
Total zapodid captures	8	2			5	2		
Tamias striatus	0	0			2	2	68.1	91.8
Eutamias minimus	9	7	41.0	45.1	40	18**	49.3	47.4
Total sciurid captures	9	7			42	20**		
Total, all species	583	297***			669	696		

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

Specials and Victors ($P > 0.5$). Relative to Museum Specials, therefore, Victors captured proportionally fewer of all species, but Holdfasts captured more soricids, an equal number of cricetids, and fewer zapodids and sciurids.

In contrast to my results, other studies have shown significant differences among species in their capture rate by Museum Specials and Victors. I tested data presented by Smith et al. (1971) and Wiener and Smith (1972) for differences in the proportions of species captured 10 or more times in Museum Special–Victor pairs, and found that the difference was significant in both studies ($P < 0.001$). Small-mammal trappers, therefore, should be aware of these differences and choose their trap type(s) accordingly.

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Probable Hybrids of Cinnamon × Blue-winged Teal from Southern Alberta[1]

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Plumage characteristics of three recent and nine previously reported probable hybrid Cinnamon × Blue-winged Teal are summarized: males are the rufous color of Cinnamon Teal but retain the white facial crescent and often the white flank patch of the Blue-winged Teal.

Key Words: Alberta, hybrids, Cinnamon Teal, Blue-winged Teal, *Anas cyanoptera, Anas discors.*

Until recently most of our knowledge on the occurrence of Cinnamon (*Anas cyanoptera*) × Blue-winged (*A. discors*) Teal hybridization has come from aviaries. Kortwright (1942; p. 212) states that " . . . even in captivity crosses between the two species are unknown." Delacour and Mayr (1945), however, state that the two species freely interbreed. Spencer (1953; p. 20) states that "although extremely uncommon among wild Cinnamon Teal, hybrids are by no means unknown." Of the Blue-winged Teal, Delacour (1956; p. 170) remarks that "In captivity they cross too readily with Cinnamon Teal, and when both species are kept on the same pond it is usual to rear a majority of hybrids . . . This is the more surprising that these two closely allied Teal seldom cross in the wild state in the rather narrow areas where they co-exist in North America." He goes on to say that Cinnamon Teal " . . . persecute the weaker Blue-winged Teal . . ."

In recent years there has been an increasing number of reports of wild Cinnamon × Blue-winged Teal hybrids; many of these have come from southern Alberta and Saskatchewan (Wedgewood and Wedgewood 1975; Lang 1973; Lahrman 1971). Also there have been reports of male Cinnamon Teal and Blue-winged Teal simultaneously courting a single female of one of the species (Butot 1974; Anderson and Miller 1953).

In the spring of 1974, we observed three ducks which we believe were male hybrids of Cinnamon and Blue-winged Teal. One individual was observed on 20 May at 16:55, and another at 17:02 at a slough 0.5 km east of the southeast corner of Eagle Lake, near Namaka, approximately 56 km east-southeast of Calgary, Alberta. The first duck was alone and swam from view within 2–3 min of being sighted. The second bird was in the company of two normally plumaged male Cinnamon Teal and a female typical of the nearly identically appearing Blue-winged and Cinnamon Teal females. The third individual was observed by us on 9 June at 19:45, at Second Vermilion Lake, Banff, Alberta. It was in the company of two normally plumaged male Cinnamon Teal and a female of either teal species.

A search of literature as well as present sightings yields 11 field descriptions of apparently wild Cinnamon × Blue-winged Teal hybrids. It is not surprising that all individuals have been male as hybrid females would be virtually undistinguishable in the field. We have described the major plumage characteristics in Table 1.

In summary, the plumage of male Cinnamon × Blue-winged Teal hybrids may be characterized as follows: a body having the rufous coloration of the Cinnamon Teal and the white facial crescent of the Blue-winged Teal; the white flank patch of the latter is often present and the breast is sometimes spotted.

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TABLE 1—Plumage features of male Cinnamon × Blue-winged Teal hybrids

Body coloration	White facial crescent	White flank patch	Breast spotting	Location and source
1. Dark cinnamon	Distinctive	Distinctive		Utah; Wilson and Van den Akker 1948
2. Cinnamon	Snow-white			Colorado; Bent 1923
3. Cinnamon	Distinct	Believed lacking		Utah; Spencer 1953
4. Cinnamon	Prominent			Alberta; Spencer 1953
5. Cinnamon	Clear		Indistinct	California; Anderson and Miller 1953
6. Reddish	Washed out*	Prominent*	Present	Saskatchewan; Lahrman 1971
7. Cinnamon	Faint			Alberta; Lang 1973
8. Rusty red	Small	Light		Saskatchewan; Wedgewood and Wedgewood 1975
9. Cinnamon	Prominent	Prominent		Alberta; this paper
10. Cinnamon	Washed out	Absent		Alberta; this paper
11. Rufous-cinnamon	Washed out	Washed out		Alberta; this paper

*Authors' interpretation from photo.

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Common Garter Snake Predation on Ring-billed Gull Chicks

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A Common Garter Snake was observed eating two freshly hatched Ring-billed Gull chicks.

Key Words: Common Garter Snake, Ring-billed Gull chicks, predation, *Thamnophis sirtalis, Larus delawarensis.*

In this note I describe an act of predation upon Ring-billed Gull (*Larus delawarensis*) chicks by a Common Garter Snake, *Thamnophis sirtalis*. The gull colony is on Mugg's Island, Toronto Harbor, Toronto, Ontario. The observation was made from a blind situated in a Ring-billed Gull colony of approximately 6000 pairs. About 50 pairs of Herring Gulls, *L. argentatus,* also nest on the island.

The incident began at 07:35 EST on 25 May 1978 as the snake moved from beneath the platform which supports the blind. The 80-cm reptile moved approximately 4 m to the edge of a gull nest which contained three chicks. Two chicks were about 48 h old and the third was less than 24 h old. Freshly hatched chicks average 35–45 g. The snake tested one half of an eggshell lying at the nest rim with its tongue, grasped the shell between its jaws, and moved it about 20 cm from the nest. The snake then raised its head approximately 5 cm above the substrate, froze momentarily, and lunged rapidly at a chick, seizing it by the bill. The snake engulfed the chick up to the wings within 4 min and then writhed several times.

The chick was gone from view 14 min after capture, and the snake remained stationary for a few minutes more. As it contorted slowly and rubbed its nose in the sand, the obvious bulge moved posteriorly.

Following this respite, the reptile inched its way toward a nest about 1 m distant which contained eggs. The contents were tested with the tongue, and the snake continued to two adjacent nests with eggs where it performed the same operation. Finally, a nest with two 48-h-old chicks was reached. The two chicks were different in size, and the Garter Snake seized the smaller one by the throat. The snake released the chick long enough to grasp it by the bill as it had done with the first victim. The swallowing behavior which followed was similar to that in the first predatory act 23 min earlier, and 11 min after it grasped the chick the snake disappeared beneath the blind. At that time, 80% of the chick had disappeared within the snake's jaws.

The gulls' reaction to the snake was interesting. Hatching had just started in the area and during the entire incident all chicks remained in the nest bowls or on their rims. Adult gulls stood about 0.75 m from the snake and called loudly, using the 'Kow-Kow' call described by Moynihan (1956). Adults displayed no anti-predator behavior (Krunk 1964) and none took flight at the sight of the reptile.

Gull chicks are consumed by avian and mammalian predators such as the Great Horned Owl, *Bubo virginianus* (Burger 1974); Marsh Hawk, *Circus cyaneus* (Burger 1974); Mink, *Mustela vision* (Burger 1974); Hedgehog, *Erinaceus europaeus* (Kruuk 1964); Red Fox, *Vulpes vulpes* (Kruuk 1964; Burger 1974). Campbell (1969) reported that the Wandering Garter Snake, *T. elegans vagrans,* preyed upon Glaucous-winged Gull, *L. glaucescens,* chicks. Birds are rare in the diet of *T. sirtalis* (Hamilton 1951; Fouquette 1954; Fitch 1965; Gregory 1978). Thus, consumption of Ring-billed Gull chicks may be a special case of opportunistic feeding. Campbell's observations of Wandering Garter Snake predation on Glaucous-winged Gull chicks occurred in an ecological situation similar to that on Mugg's Island. In both cases, the snakes were the only observed reptilian inhabitants of the islands used by nesting gulls. Perhaps the snakes, which use olfaction to detect food (Fox 1952; Burghardt 1970), were originally attracted to the colonies by the odor of fish scraps dropped by the gulls. The Wandering Garter Snake ate food pellets regurgitated by gulls (Campbell 1969). The fact that the snake on Mugg's Island struck at and grasped the fresh eggshell, which was unlikely to smell of fish, suggests that the snake may have utilized chick odor in its hunting behavior. It is difficult to assess the frequency of gull chick predation by the Common Garter Snake on Mugg's Island, for it has only been observed once in over 1200 h of observations in the past 4 yr. Therefore the incident reported here is probably an example of a predator taking a locally abundant, easily obtained food source not normally in its diet.

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The Rock Vole (*Microtus chrotorrhinus*) as a Transition Zone Species

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Kirkland, Gordon L., Jr. and Charles M. Knipe. 1979. The Rock Vole (*Microtus chrotorrhinus*) as a Transition zone species. Canadian Field-Naturalist 93(3): 319–321.

Rock Voles (*Microtus chrotorrhinus*) were collected in mixed northern hardwood forests in New York's Adirondack Mountains at elevations between 460 and 700 m. These voles were much more common in the Transition zone habitats than previously thought. Data are presented on the habitat, relative abundance, and ecological associates of the 43 specimens.

Key Words: Rock Vole, *Microtus chrotorrhinus*, Adirondack Mountains, Canadian zone, Transition zone.

Rock Voles (*Microtus chrotorrhinus*) have traditionally been considered to be boreal small mammals. Recent research at the periphery of their range indicates that Rock Voles are not only geographically more widespread than previously believed, but they have greater ecological amplitude as well (Buech et al. 1977; Kirkland 1977; Roscoe and Majka 1976; Timm 1974; Timm et al. 1977). In the northeastern United States, Rock Voles have been thought to be limited in distribution to higher elevations and more boreal habitats. Martin (1971a) states that the Rock Vole is most closely associated with the Canadian life zone. Furthermore, he notes that records of the Rock Vole in the Transition zone may be explained on the basis of expansion of the Rock Vole's distribution under suitable conditions from the sanctuary of more favorable Canadian zone habitat. Examination of the distribution of captures of the Rock Vole in New York's Adirondack Mountains prior to 1970 tends to confirm this traditional view of the ecological distribution of the Rock Vole. With the exception of a series of 29 specimens collected by C. F. Batchelder at Keene Heights (elevation 400 m), 61 of 91 specimens examined in museum collections were taken at elevations above 976 m, which is the lower limit of Red Spruce (*Picea rubens*)-dominated forests in the Adirondacks (Braun 1964). Since 1970, however, 43 Adirondack Rock Voles collected by Shippensburg State College Vertebrate Museum field personnel have been trapped at elevations below 1100 m. In addition, F. J. Jannett, Jr. (Cornell University) and R. Rosen (University of Vermont) (personal communications) have obtained for use in laboratory studies 20 live Rock Voles at elevations between 640 and 760 m in the Adirondacks. These recent records reveal that Rock Voles are more widespread and abundant in Transition zone habitats than was previously believed. This paper presents information on the habitat, relative abundance, and ecological associates of 43 *M. chrotorrhinus* captured from 1973–1978 at elevations of 460 to 700 m in Essex County, New York.

Methods

The 43 Rock Voles described in the paper were collected in 10 traplines (Table 1) representing seven localities, as follows: New York, Essex County, St. Hubert's, 2.7 km SE, elevation 457 m (1); Tahawus, 0.40 km SE, elevation 549 m (1); 1.9 km W, elevation 549 m (1); 7.9 km NNW, elevation 640 m (26); 8.7 km N, 3.2 km W, elevation 670 m (9); Wallface Mountain, 0.8 km SW, elevation 700 m (4); 3.2 km SW, elevation 625 m (1). The specimens were obtained as part of a small mammal survey of Essex County, New York. Sampling procedures involved establishing traplines with variable numbers of stations, usually with three snap-traps per station. Museum Specials baited with rolled oats were used principally, although each line might have up to 10% rat and/or mouse traps. At each station, the traps were set within 2 m of each other, and traplines were operated for either 2 or 3 d. The 10 traplines yielding Rock Voles had a total sampling effort of 2691 trapnights (TN).

Results and Discussion

The trapline and specimen records for the 43 Rock Voles reveal that 42 were captured in typical Transition zone forests dominated by Yellow Birch (*Betula lutea*), Sugar Maple (*Acer saccharum*), and American Beech (*Fagus grandifolia*). The only exception was the single capture along a stream, 2.7 km SE St. Hubert's, in a Red Spruce – Eastern Hemlock (*Tsuga canadensis*) association. All specimens were captured at sites where rocks or boulders were conspicuous habitat components and the canopy was semi-open. Six of the seven localities at which 42 of the Rock Voles were captured had streams of varying sizes flowing through them. Martin (1971a) notes that 47 of 83 Rock Voles he collected were caught within 30 ft (9 m) of running water, either surface or subsurface.

The microhabitats of the Rock Voles in this study tended to be characterized by the presence of rocks, mosses, ferns, and forbs (e.g., *Oxalis, Clintonia, Viola*, and *Smilacina*). The percentages of Rock Voles collected within 1 m of these four microhabitat

TABLE 1—Small mammals captured in 10 traplines yielding Rock Voles in Transition zone habitats of Essex County, New York

Species	Trapline number, year, elevation (m), sampling effort (TN)										Totals
	1, 1973, 549, 450	2, 1975, 457, 441	3, 1975, 549, 540	4, 1975, 625, 300	5, 1975, 700, 300	6, 1977, 640, 240	7, 1977, 640, 240	8, 1978, 640, 120	9, 1978, 640, 120	10, 1978, 700, 240	2691TN
Masked Shrew (*Sorex cinereus*)			6	3	1	2				4	16
Long-tailed Shrew (*Sorex dispar*)		2			1		2	1	2	1	9
Smokey Shrew (*Sorex fumeus*)		3						2	1		6
Water Shrew (*Sorex palustris*)					2						2
Short-tailed Shrew (*Blarina brevicauda*)	5	4	24	12	5	7	10	1		1	69
Chipmunk (*Tamias striatus*)	2		3	1							6
Red Squirrel (*Tamiasciurus hudsonicus*)					1						1
Northern Flying Squirrel (*Glaucomys sabrinus*)				1	1						2
Deer Mouse (*Peromyscus maniculatus*)	6	8	16	14	11	4	2	2	2	4	69
Red-backed Vole (*Clethrionomys gapperi*)	1	16	14	8	11	9	25				84
Rock Vole (*Microtus chrotorrhinus*)	1	1	1	1	4	14	10	1	1	9	43
Meadow Vole (*Microtus pennsylvanicus*)					1						1
Woodland Jumping Mouse (*Napaeozapus insignis*)	3	1	11	4	5	4	2	2	2		34
Meadow Jumping Mouse (*Zapus hudsonius*)										1	1
Totals	18	35	75	44	43	40	51	9	9	19	343

components were as follows: rocks (66%), mosses (88%), ferns (85%), and forbs (91%). Live ground cover at individual capture sites varied from less than 25 to more than 75% but averaged 50–60%. The Rock Voles appeared to spend a considerable portion of their time in subterranean activity. In this survey, 53.5% of the specimens were caught in traps set under rocks or below the surface of rocky sites, and 65% of the total were caught in "unexposed" sites, either under rocks, logs, roots, or overhangs.

The 43 Rock Voles were captured in association with 13 other species of small mammals (Table 1). They were most frequently captured in association with Deer Mice (*Peromyscus maniculatus gracilis*), Short-tailed Shrews (*Blarina brevicauda*), and Woodland Jumping Mice (*Napaeozapus insignis*). Although collected in only 7 of 10 traplines, Red-backed Voles (*Clethrionomys gapperi*) were the most abundant ecological associate with a total of 84 specimens. Martin (1971b) noted that he collected a "relatively unchanging proportion of approximately three *C. gapperi* for every *M. chrotorrhinus* in favorable rock vole habitat." In this study, the proportion of *C. gapperi* to *M. chrotorrhinus* was 2.0:1.0; however, this varied considerably between traplines. In individual traplines, the ratio of these two species ranged from 16:1 in favor of *C. gapperi* to 9:0 in favor of *M. chrotorrhinus*.

In October of 1965 and 1966, J. N. Layne and students from Cornell University sampled small mammals on Whiteface Mountain, Essex County, New York. They collected 20 *M. chrotorrhinus* at elevations from 1128 to 1433 m in 10 of their traplines, with a total sampling effort of 1069 TN. These previously unpublished data permit some comparisons of Rock Voles inhabiting Canadian and Transition zones in the Adirondacks. The catch per unit sampling effort of 1.87/100 TN for the Whiteface Mountain sampling was slightly higher but did not differ significantly from the 1.60/100 TN for the Transition zone sampling in this study ($0.75 > P > 0.50$). This indicates that in the Adirondacks, Rock Voles may have comparable population levels in suitable Canadian and Transition zone habitats. The 20 Rock Voles on Whiteface Mountain were captured in traplines yielding seven other species of small mammals as follows: Masked Shrew (*Sorex cinereus*) (3), Long-tailed Shrew (*Sorex dispar*) (6), Smokey Shrew (*Sorex fumeus*) (1), Short-tailed Shrew (3), Deer Mouse (12), Red-backed Vole (27), and Meadow Vole (*Microtus pennsylvanicus*) (5). It is of interest that on Whiteface Mountain, the ratio of Red-backed Voles to Rock Voles was only 1.4:1.0. A Spearman Rank Correlation analysis (Siegel 1956) of the species of small mammals collected on Whiteface Mountain and in the Transition zone habitats (Table 1) reveals a significant correlation ($r_s = 0.696$, $P < 0.05$) between the relative abundance of species in small mammal communities containing Rock Voles in the two ecological zones. Thus, although the Rock Voles are occupying dissimilar plant communities, they are members of qualitatively similar small mammal communities.

The recent capture of Rock Voles at a variety of locations in the Transition zone of the Adirondack Mountains suggests that traditional assessments of

this species' ecological distribution should be re-evaluated. Rather than being restricted primarily to boreal habitats characteristic of the Canadian zone, the Rock Voles also occupy sites in northern hardwood forests where appropriate microhabitat components are present, specifically rocks, flowing water, mosses, ferns, and forbs.

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Eastern Limit of the five-lined Skink, *Eumeces fasciatus,* in Ontario

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Ussher, Richard D. and Francis R. Cook. 1979. Eastern limit of the Five-lined Skink, *Eumeces fasciatus,* in Ontario. Canadian Field-Naturalist 93(3): 321–323.

New records are reported for the Five-lined Skink, *Eumeces fasciatus,* from Frontenac County (Palmerston Lake: 2.4 km W of Snow Road; and 1.6 km SE of Snow Road Station), Lanark County (Robertson Lake), and Leeds and Grenville (Landon Bay) County. The similarities between the eastern range limit in Ontario of the skink and those of the Northern Ribbon Snake and Black Rat Snake are discussed; the adjacent more poorly-drained lowlands are suggested as a distribution barrier.

Based on collections reported by Patch (1934), Logier and Toner (1961, p. 59) cited Arden and Mountain Grove in Frontenac County as the most eastern localities at which the Five-lined Skink, *Eumeces fasciatus,* had been taken in Canada. Records accumulated since this publication allow a better definition of the eastern limit of its distribution.

On 30 August 1961, seven skinks were found by Cook and M. Gordon Foster 1.5 mi (2.4 km*) W of Highway 509 at Snow Road, Frontenac County (these are now in the National Museums of Canada, Collection Number 5618). They were inhabiting a rocky outcropping in the vicinity of a deserted hillside farmsite. One individual was discovered under a board at the farmsite; the others were under generally flat rocks in the adjacent woods and hillside. The woods were primarily White Pine (*Pinus strobus*) but a mixture of deciduous trees was also present. A thick layer of pine needles covered most of the ground in the wooded area. Old lumber piles and scattered loose boards were prevalent at the farm site, and loose rocks were common in the woods and on the hillside.

Additional records in this region include a single

individual taken by D. Scobie on 31 July 1960 from near Palmerston Lake, about 2 mi (3.2 km*) up the lake from Ompah (NMC 5110); one specimen collected on 10 August 1961 by A. G. Walker 1 mi (1.6 km*) SE of Snow Road Station, Palmerston Township, Frontenac County (Carleton University Museum of Zoology; D. A. Smith, personal communication); and one specimen collected by F. C. Zufeldt in May 1962 from Robertson Lake (NE of Lavant), Lanark County (NMC 6507). The map in Conant (1975) is based on the National Museum of Natural Sciences records, but individual localities have not been previously published.

Luciuk and McCabe (1971) noted that the species is reported to occur at "3rd Depot Lake" and at Perth Road Bay near Chaffey's Locks. The latter locality is about midway between Snow Road Station and Gananoque.

On 22 August 1973 at the Landon Bay Campsite on the north shore of the St. Lawrence River, Ussher observed a single individual. The locality was a bare patch of Precambrian rock, some 30 m above the water of Landon Bay, 8.5 km E of Gananoque in Leeds and Lansdowne Township, Leeds and Grenville County. This sighting is the only one from the area by Ussher, although he became a resident of Leeds and Grenville County in 1970, and visited this locality and similar ones on many occasions.

East of these records, in the Ottawa District, (a 48-km radius around the National Capital) where herpetofaunal surveys have been undertaken by the National Museum of Natural Sciences for several decades, and near Bishop's Mills in Leeds and Grenville County, where Cook has resided since 1970, there have been neither sightings nor reports of skinks.

Of interest is the roughly similar eastern limit of two other Ontario reptiles, the Black Rat Snake, *Elaphe obsoleta obsoleta*, which is known to occur from just south of Smith's Falls to Mallorytown (NMNS files including personal communications from R. V. Lindsay, John Woods, Roger E. Roy, Harold Parsons, and Al MacDonald), and the Northern Ribbon Snake, *Thamnophis sauritus septentrionalis*, which reaches the "Horseback Mountains" near Pakenham (Cook 1968) and slightly beyond (Tony Tobias, personal communication) and Mallorytown Landing (Woods and Cook 1976). In his review of the herpetofauna of the Thousand Islands Region, New York, Werner (1959) reported both the Black Rat Snake and the Ribbon Snake, but not the Five-lined Skink.

None of these three species have been reported from east of the rough and relatively well-drained elevated terrain of the Precambrian Shield topography, onto the adjacent low-lying, and relatively more poorly-drained area which was covered by the postglacial Champlain Sea of the Ottawa and St. Lawrence valleys. Nor have any been reported on the eastern side of this presumed barrier, in the Precambrian of the Gatineau and Laurentian regions between Ottawa and Montreal.

The populations of these three species reported in Leeds and Grenville, Frontenac, and Lanark counties may be prevented from colonizing the lowlands at the northeastern edge of their range by a lack of well-drained hibernating sites and the lack of sufficient insulation that is provided by deep accumulations of snow in the hollows of the adjacent broken topography. The moderating effect of the Rideau Lakes system on local microclimates, possibly promoting warm pockets, and the less intensive agriculture on its rough terrain, leaving more of the area in forest, are additional factors that may contribute to the survival of these species in the area. Their eastern limit roughly corresponds to the eastern boundary of Herpetofaunal Section 1 defined by Bleakney (1958), which is based on mean July temperature and the length of the growing season.

A fourth species, the Stinkpot, *Sternotherus odoratus*, reaches its eastern limit in the general area, but it invades the lowlands along the Rideau and Mississippi rivers at least as far as Beckets Landing (NMC 3938) in Leeds and Grenville counties and Innisville (NMC 2157) and Pakenham (NMC 13777) in Lanark County. Perhaps its different overwintering habitat, in these rivers does not place on it the same constraints for hibernation sites that are suggested for the terrestrially hibernating species discussed above.

Additional observations of any of these species at the eastern edge of their range, giving locality, habitat, date, number observed, and observer(s) name(s) would be appreciated by the authors. Information on the status of the Black Rat Snake is also being collected for the Ontario Ministry of Natural Resources by Harold Parsons and Al Macdonald as part of a detailed study of it in the Rideau Lakes region, and by the Federation of Ontario Naturalists in a general survey of its Ontario range. Because sightings of any of these species are often a matter of chance, and because populations may be scattered and fluctuating in abundance from year to year, the cumulative interest and efforts of all observant naturalists is needed further to define their ranges. A more precise discussion of these limiting factors must wait until such observations are available, and should also include comparison with the northern limit of these species. The latter may roughly correspond (with the notable exception of the Black Rat Snake) with the southern boundary of the 300-m contour and a large height of land covering the Haliburton and

*Collectors originally stated distances in whole or half miles.

Algonquin highlands (*see* map in Weller and Palermo 1976; W. G. Sprules and W. F. Weller, personal communication).

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Barn Owls in Quebec

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David, Normand. 1979. Barn Owls in Quebec. Canadian Field-Naturalist 93(3): 323–324.

An evaluation of Barn Owl records in Quebec shows that there is no conclusive evidence that the species has actually bred within the province.

Key Words: *Tyto alba,* Quebec.

Information from F. Crète, then Director of the Museum of the Deaf and Dumb Institute of Montreal, provided the only suggestion of breeding of the Barn Owl (*Tyto alba*) in Quebec, at Berthierville, Berthier County, in 1931 (Cayouette 1947; Godfrey 1966). The unpublished ornithological notes of the late Victor Gaboriault, however, show that breeding of Barn Owls in Berthierville in 1931 was never substantiated. An evaluation of that record and of other reported occurrences in the province indicates that the Barn Owl is a casual visitor, but gives no indisputable evidence that it breeds here.

Early in 1945, R. Cayouette learned that a "dozen Barn Owls" had been seen in Berthierville around 1931, and he was referred to Crète for further details. Crète indicated that a pair, discovered by A. Paquette, had nested in the church steeple, that from the four young he had received one in the flesh which was mounted by a local taxidermist, and that Paquette had given him a mounted specimen on 29 December 1931. Crète added that he kept the second specimen and gave the first to the museum of Collège de Sainte-Anne-de-la-Pocatière. With his letter Crète included copies of the label and of the accession card of the specimen given to him by Paquette. According to the label the specimen (No. 31/16) is an adult male captured on 10 November 1931; on the accession card, however, Crète wrote that this bird was killed in November 1931, from a brood of four whose parents had settled in the church steeple.

On 28 March 1946, Gaboriault interviewed Paquette and was told that high winds had been blowing for several days when about 20 Barn Owls appeared in the Berthierville Islands in 1931. After a while they took refuge in the church steeple where Paquette killed eight birds. He mounted one which is at the Deaf and Dumb Institute, and sent the others to various museums. As the steeple floor was covered with droppings, it was evident several birds had been there for some time. Paquette could not give more definite details.

Paquette's recollection is confirmed by a posthumous article (Paquette 1961) which he read in French at the fiftieth meeting of the AOU at Quebec City in 1932 (see The Auk 50, p. 74). Relating his observations on birds of prey in captivity he said that about 15 Barn Owls had settled in Berthierville, and that he kept one bird for a week in order to study its postures before mounting it.

Gaboriault's list of Barn Owl specimens taken in

TABLE 1—Records of occurrence of the Barn Owl in Quebec

Locality	Date	Remarks[1]	References
Longueuil	October 1915	Captured by W. J. Low	V. Gaboriault
L'Assomption	November 1926	Captured	Auk 64, p. 631
Longueuil	1 November 1931	Deaf and Dumb Institute Museum	V. Gaboriault
Berthierville	November 1931	Captured by J. Desjardins	V. Gaboriault
Berthierville	10 November 1931	At least 3 captured by A. Paquette	V. Gaboriault
St.Félix-de-Kingsey	15 June 1936	Captured in a barn	PSNHC[2] Annual Report 1938, p. 161
Beauharnois	12 May 1944	Captured by V. Gaboriault	V. Gaboriault
Thetford Mines	3 September 1944	Captured in a barn	Auk 64, p. 631
Saint-Hubert	1961	One "pair" seen in summer	PQSPB[3] Annual Report 1961, p. 25
Giffard	18, 24 June 1963	Sight records	Bulletin ornithologique 8(4), p. 3
Berthierville	14 April 1967	Sight record	Bulletin ornithologique 12, p. 19
Mont-Carmel	30 May 1968	Captured in a barn	Bulletin ornithologique 13, p. 37
Cap Tourmente	20 December 1970	Found dying	Bulletin ornithologique 15, p. 95
Cap Tourmente	22 December 1970	Sight record	Bulletin ornithologique 15, p. 95
Rigaud	12 June 1971	Captured in a barn	Bulletin ornithologique 16, p. 58
Cap Tourmente	8 May 1974	Found dead	Bulletin ornithologique 19, p. 24
Near Montreal	Spring 1975	Shot	American Birds 29, p. 830
Huntingdon	Fall 1975	Killed by a car	American Birds 30, p. 696
Saint-Coeur-de-Marie	1975	Captured in a barn	Bulletin ornithologique 21, p. 54
Masson	July 1977	Captured (female in breeding condition)	Henri Ouellet (pers. comm.)

[1]One individual only unless otherwise stated.
[2]The Provancher Society of Natural History of Canada.
[3]The Province of Quebec Society for the Protection of Birds.

Quebec shows only three extant specimens from the birds killed in Berthierville by Paquette in 1931: one of unstated age and sex in a Berthierville school museum, another of unstated age and sex in the museum of Collège de Sainte-Anne-de-la-Pocatière, and an adult in the museum of the Deaf and Dumb Institute (No. 31/16), "from a group of 4 or 5 which had taken refuge in the church steeple." This annotation shows clearly that Gaboriault was convinced that the species had not bred. None of the extant specimens was a flightless young, and Paquette never said that the birds had nested. Paquette may have exaggerated the number of birds seen, and Crète perhaps assumed that only breeding could explain such a number of birds.

What appears to be the correct evaluation of the record is found in Gaboriault's notes. On a map of Quebec he had marked records of occurrence with different keyed symbols according to their seasonal status. The symbol indicating the Berthierville record on the map of the Barn Owl corresponds to a fall visitor.

The records of occurrence to date (Table 1) show only a pattern of casual vagrancy in the St. Lawrence lowlands, with exceptional records eastward to Kamouraska County (Mont-Carmel) and northward in the Lake St. John area (Saint-Coeur-de-Marie). The most recent record though suggestive, did not provide conclusive evidence that the Barn Owls actually bred within the limits of the province. A bird in breeding condition was captured in a field near Masson, Papineau County, only 1.5 km north across the Ottawa River from the Ontario border; it was seized by game wardens 1 or 2 d later, on 21 July 1977. The specimen, now preserved in the National Museum of Natural Sciences of Canada (No. 67191), is a female having a refeathered brood patch; its reproductive tract contained 10 empty follicles and several ova, the largest measuring 16 mm (Henri Ouellet, personnal communication).

I thank Wilfrid Gaboriault who kindly lent me the ornithological notes of his late brother. I also thank Raymond Cayouette who allowed me to examine his correspondence with F. Crète. Henri Ouellet reviewed the manuscript. Victor Gaboriault died before he could write a planned account on the distribution of birds in Quebec; for this important contribution, he should be considered as the author of this note.

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Communal Roosting of Song Sparrows under Snowbank

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McNicholl, Martin K. 1979. Communal roosting of Song Sparrows under snowbank. Canadian Field-Naturalist 93(3): 325–326.

Fifteen Song Sparrows (*Melospiza melodia*) were found roosting under an ice-encrusted snowbank on Prince Edward Island. The birds appeared to be keeping warm by a combination of roosting under snow and reducing individual distance.

Key Words: Individual distance, Prince Edward Island, Song Sparrow, sub-nivean environment, winter survival.

At 06:55 on 7 April 1977 I was about to cross a stretch of snowbank 50 m long by 1 m wide in a ditch in front of a farmhouse near French River, Prince Edward Island, when 15 Song Sparrows (*Melospiza melodia*) emerged in rapid succession from a hole approximately 4 cm in diameter in the bank. Examination of the hole showed that it led via a short tunnel (approximately 10 cm long) to a small cavity, approximately 18–20 cm long by 11–14 cm wide, and 8 cm high, with no other exit. Previous melt had caused the snowbank to become encrusted with ice. The temperature was –2°C at the time, but with strong north winds felt much colder. (I was uncomfortably cold in an "Eskimo-style parka in which I am normally warm in –20°C weather in the prairie provinces.)

Nice (1943, p. 106) stated that Song Sparrows roost in "weeds, hedges and small evergreens," and I have found no references to their roosting in holes or under snowbanks. Sub-niveal roosting has been recorded for Common Redpolls (*Carduelis flammea*) (Cade 1953; Novikov 1972), Dark-eyed Juncos (*Junco hyemalis*) (Linsdale 1928), Tree Sparrows (*Spizella arborea*) (Thompson 1934), Snow Buntings (*Plectrophenax nivalis*) (Bagg 1943), and several Eurasian passerines (Novikov 1972). In a recent summary of several earlier accounts of passerines roosting under the snow in Finland and the Soviet Union, Novikov (1972) concluded that several species which regularly winter in snow-covered areas frequently roost under snow. Unlike most of the above-mentioned species, Song Sparrows do not usually winter in snow-covered areas, although many return to northern nesting areas before all snow is gone, and there are many records of individual birds wintering in northern areas.

Kendeigh (1961) demonstrated the energetic advantage to birds of roosting in cavities, and the well known insulative properties of snow (Formozov 1946; Elsner and Pruitt 1959) would enhance such an advantage. This insulative ability of snow, however, is poorest when the snow has been penetrated by water or converted to ice, as in the present case. Thus, even under the snowbank, the sparrows may have been under considerable cold stress, a condition known to induce breakdown of individual distance, resulting in clumping together (Beal 1978). Although such crowding together is reported for several colonial or flocking species in cold weather (e.g., Grubb 1973; Meservey and Kraus 1976), I am not aware of reports of such behavior in a species such as the Song Sparrow which shows intraspecific intolerance all year (see Nice 1943). As territorial behavior tends to be particularly strong shortly after return to the nesting area in spring, this observation of communal roosting appears particularly remarkable.

Thus, the sparrows I observed appear to have combined the strategies of roosting under snow and clumping together to keep warm. In such a territorial species, such a breakdown of individual distance likely occurs only rarely.

I thank Anthony J. Erskine, William O. Pruitt, Jr., and two anonymous referees for helpful comments on the manuscript.

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Status of Eastern White Cedar, *Thuja occidentalis,* in Western Nova Scotia

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Ringius, Gordon S. 1979. Status of Eastern White Cedar, *Thuja occidentalis* in western Nova Scotia. Canadian Field-Naturalist 93(3): 326–328.

The occurrence of Eastern White Cedar, *Thuja occidentalis*, in western Nova Scotia, in doubt since the initial report published in 1877, is confirmed. A brief account of four of the five known stands in Cumberland County is presented and a map showing the distribution of the species in Nova Scotia is included.

Key Words: *Thuja occidentalis*, rare, Cumberland County, distribution.

The earliest record of Eastern White Cedar, *Thuja occidentalis*, from western (= Cumberland County) Nova Scotia was published in 1877 by Lindsay. Confirmation of Lindsay's report has not been forthcoming, however, and as a result, subsequent authors (Table 1) have either cited Lindsay (Bentley and Smith 1962), included it without explanation (Maher et al. 1978; Saunders 1970), suggested that the species may be present (Roland 1947), or have excluded it (Loucks 1962; Roland and Smith 1969). The purpose of this note is to confirm the presence of *Thuja occidentalis* in western Nova Scotia and to indicate where the known stands are located.

On 1 April 1977, I observed a small stand of *Thuja occidentalis* along the Trans-Canada highway about 5.8 km E of the River Phillip – Oxford junction (45°43′N, 63°50′W). The stand was located near the base of a west-facing slope adjacent to a Speckled Alder (*Alnus rugosa*) – Tamarack (*Larix laricina*) swamp and consisted of less than 50 mature trees scattered over an area of approximately 5 ha. The trees were sparsely branched, many had single and double bifurcate stems, and most showed reddish brown discoloration of the lower and peripheral foliage. The presence of numerous previous years' cones indicated that the stand was producing seed. Because snow still covered much of the ground, however, no attempt was made to locate seedlings or saplings. A voucher specimen was collected and has been placed in the Smith Herbarium at Acadia University (Ringius 796).

To determine whether other stands of *Thuja occidentalis* have been located in western Nova Scotia, I examined the collections at ACAD, DAL, DAO, and NSPM (acronyms from Holmgren and Keuken 1974). In addition, I contacted several people who are involved with forestry in Nova Scotia. As a result of these investigations, I discovered four additional stands, and a previous unpublished account of the stand described above. The locations of these stands are shown in Figure 1.

On file at NSPM are the following two reports taken from the Chignecto Peninsula Inventory:

> Eatonville near Apple River, Cumberland Co., a cedar swamp less than one acre [0.4 ha] in size. Sandy MacGregor, Forestry Superintendent, Scott Paper Company, New Glasgow.
>
> A few miles southeast of Oxford, Cumberland Co., scattered cedar trees located along the trans-Canada [highway] in this area. Also a few cedar swamps of about 5 or 6 acres [2.0 – 2.4 ha] each between the

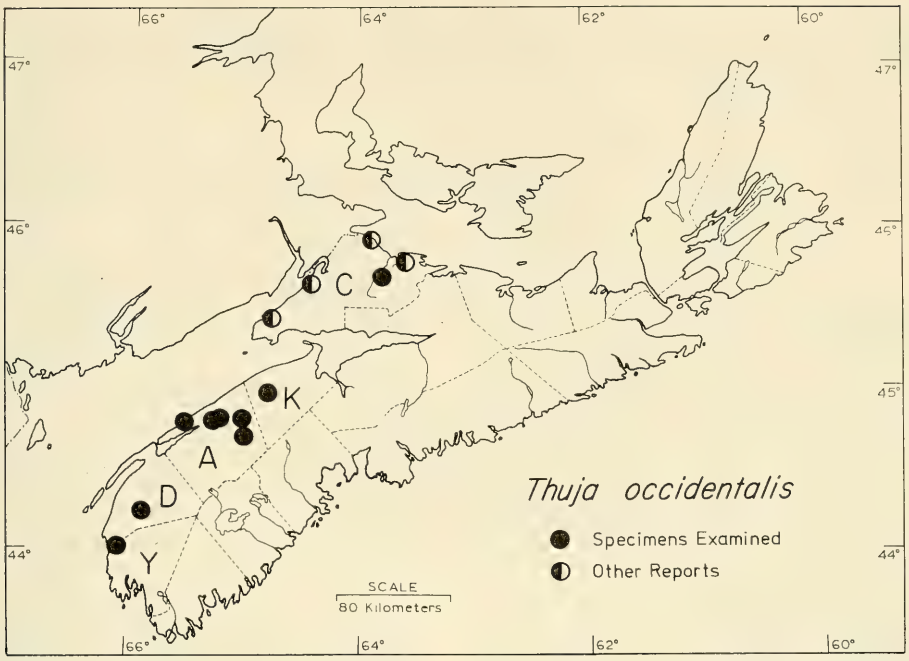

FIGURE 1. The distribution of Eastern White Cedar, *Thuja occidentalis*, in Nova Scotia, based on specimens examined at ACAD, DAL, DAO, and NSPM, and on reports obtained through correspondence. A — Annapolis County, C — Cumberland County, D — Digby County, K — Kings County, Y — Yarmouth County.

highway and the railroad. Cedar, which used to be very common in Cumberland Co., is now rare and there are only a few cedar stands remaining. Department of Lands and Forests, Oxford.

S. MacGregor (personal communication 1977) stated that "the population of cedar at Apple River is native as far as I know. There are only a few stunted trees growing on a very tiny wet area." Similarly, J. H. Beattie, Supervisor Forest Resources, Department of Lands and Forests, Oxford (personal communication 1977) stated the "cedar southeast of Oxford is native." He also said there are small stands at Lorneville, Pugwash Junction, and near Joggins. All three sites are in Cumberland County. The Lorneville stand was at one time about 4 ha in size but has been seriously reduced over the years. As a result of cutting in the summer of 1977 only a few small trees of this stand remain. On his suggestion I contacted Harold V. Hatfield, Supervisor Forest Resources, District of Cumberland West, Parrsboro, who was acquainted with the Joggins stand. He provided information on its location and referred to it as a "small amount of wild cedar. [The trees] are young [and] scattered among spruce and hardwood on an old burn."

It is apparent that the stands of *Thuja occidentalis* in Cumberland County are small, scattered, and rare. In these respects they are similar to those in Annapolis, Digby, Kings, and Yarmouth counties in southwestern Nova Scotia where the species has been known to occur since about 1801 (Table 1). In an ecological study of the southwestern stands, Bentley and Smith (1962) found that although reproduction was ample as indicated by seedling density, seedling mortality was apparently high because few young trees were present in any of the stands. They concluded that competition from other tree species was the limiting factor controlling the distribution of *Thuja occidentalis* in Nova Scotia. It should be mentioned that the species grows well enough when planted; as an ornamental it is found throughout the province with the possible exception of Cape Breton Island.

I thank S. P. Vander Kloet of Acadia University, Wolfville, Nova Scotia, for reviewing an early draft of this note and offering helpful suggestions. Information supplied by J. H. Beattie, H. V. Hatfield, and S. MacGregor, and access to the various herbaria are appreciated and gratefully acknowledged.

TABLE 1—Previous reports of Eastern White Cedar, *Thuja occidentalis*, in Nova Scotia

Author	Date	Locality
Smith[1]	ca. 1801	Annapolis Valley (not plentiful)
Lindsay	1877	Cumberland County
Macoun	1886	Swamp within 3 mi [4.8 km] of Annapolis [Annapolis County], but said to grow on the Bay of Fundy near [Annapolis]; rare in Nova Scotia
Fernald	1921	Digby County, Yarmouth County (lakesides)
Roland	1947	Annapolis Valley, Digby, Yarmouth counties; possible existence on the isthmus between Nova Scotia and New Brunswick [Cumberland County]
Bentley and Smith	1962	Annapolis, Digby, Kings counties; reported from Cumberland County [*cite* Lindsay 1877]
Loucks	1962	Wentworth Lake District [= portions of Digby and Yarmouth counties]; local
Roland and Smith	1969	Annapolis Valley [includes Kings County], Annapolis, Digby counties
Saunders	1970	Annapolis Valley, Digby, Yarmouth counties; slight 'spillover' from New Brunswick on the Chignecto Isthmus [Cumberland County]
Maher et al.	1978	Annapolis, Cumberland, Digby, Kings, Yarmouth counties

[1]Cited by Gorham (1955).

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Snowy Egret in the Northwest Territories

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Quinlan, Richard W. 1979. Snowy Egret in the Northwest Territories. Canadian Field-Naturalist 93(3): 329.

Key Words: Snowy Egret, Northwest Territories, first record.

On 23 June 1977, a Snowy Egret (*Egretta thula*) was seen near Fort Simpson (61°53′N, 121°25′W). This is the first recorded sighting in the Northwest Territories and the most northerly in North America. This species breeds from the central United States through the West Indies and Central America to Chile and Argentina. It is a rare non-breeding wanderer to Alberta, Saskatchewan, and British Columbia (W. E. Godfrey, 1966. The birds of Canada. National Museum of Canada Bulletin 203). There are six records of Snowy Egrets in Alberta, all in May and June (C. S. Houston and M. I. Houston, 1976. American Birds 29: 74–77; W. R. Salt and J. R. Salt, 1976. The birds of Alberta. Hurtig, Edmonton); the most northerly was at Sandy Lake (52°47′N, 111°00′W) in May 1909. The most northerly of four Saskatchewan sightings was at Saskatoon (52°07′N, 106°38′W) on 15 May 1977 (E. M. Serr, 1977. American Birds 31: 1013–1016). Near Juneau, Alaska (58°20′N, 134°20′W), a Snowy Egret was observed 18–24 May 1957 (I. N. Gabrielson and F. C. Lincoln, 1959. The birds of Alaska. Stackpole Co., Harrisburg, Pa.)

The bird reported here was observed on the downstream (northwest) end of Fort Simpson Island in the Mackenzie River. It was first sighted on 23 June by Richard Quinlan and Yvonne Desilets, who watched it for 45 min from a distance of approximately 50 m. Quinlan, with James Steele and (once) Bruce Reilly, also saw the egret on each of the next 4 d. All observations except the last (1 km downstream on a small island) were at the original location.

A super-8 movie film taken on 25 June was viewed by Henri Ouellet of the National Museum of Natural Sciences, who verified the identification. Bernard Gollop provided a number of additional records from Alberta and Saskatchewan.

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Letters

Is Biology Unknown?

The recent Guest Editorial by Yorke Edwards, "Biology — The Unknown Science?" (Canadian Field-Naturalist 93(1): 6–9; 1979), invites a reply and several counter-proposals. Of all the sciences, Biology is probably the best known today. It has its Suzuki, and the media are full of "gee-whiz" articles on genetic engineering, tissue culture, test-tube babies, and Cinderella crops. What is missing, according to Edwards, is the synthesizing scientist who will put all these marvelous bits and pieces together "so that people may understand their world."

There are a couple of serious problems with this diagnosis. Implicit is the assumption that science is engaged in discovering reality, not making it. But suppose that at least some science (and certainly all the technology that science nurtures) is motivated not so much by a desire to understand as to control and change? Then people may rightly question whether scientists are all admirable, and whether every old kind of science is A-OK. They might, for example, ask what exactly biologists are up to when they study the deep-diving abilities of seals, or the cold resistance of wolves' feet. "Why," your innocent scientist will answer, "we mean to help our fellow men to explore safely the ocean floor for mineral treasures, and warmly to run around on the snow while searching for good Canadian oil!" "But surely," the layman responds, "you investigate these things with an enriching sense of wonder and awe, and this you will transmit to me so that I too may understand and marvel?" "Will you please go away and don't bother me," comes the reply, "I'm preparing a scientific article (on which my next promotion and merit increase depend) for one of the NRC journals and tomorrow I'm off to Ottawa as a consultant to the Department of National Defence."

A related questionable assumption is that the synthesis of knowledge needed to understand the world will come from a change in attitude of those who know the facts (the analytical scientists) rather than from a newly constituted science that sets as its goal the sympathetic understanding of world ecosystems. After all, how realistic is it to expect nuclear physicists to go to bat for Ecological Reserves, or mining geologists to take up the cudgels for a decentralized solar society? Their training is wrong, and so is the training of most biologists. It is not that Biology is unknown but that *the proper subject* is unknown.

Finally, we hear much today about morality in science, meaning that no matter what is buzzing around in their Pandora's box, scientists should carefully explain to the public the undoubted advantages of taking off the lid. Such morality is largely self-serving. There needs to be, as Aldo Leopold said long ago, a land ethic, a commitment to something external to the human race, something equally if not more important. The main problem with science, and the reason for the lack of Earthcare, is the narcissism of the human race.

J. Stan Rowe
9 March 1977

Department of Plant Ecology, University of Saskatchewan, Saskatoon, Saskatchewan 2N4 0W0

Never one to be uninterested in reactions to what I write, I gladly accept this opportunity to comment on Dr. Rowe's thoughtful comments, and I do so briefly. I read them with complete sympathy and agreement, for most of his thoughts are not far from those I hold, or have held.

Inevitably the world we see is the part of it that we are in, and my current views must therefore be colored by a long association with government and primary industry. I can only say in addition to what I have said, that I find my part of the world quite frightening because of the values used in deciding destructions of the living parts of Earth as well as of the mineral bases for that life. As Dr. Rowe probably knows, my copy of Leopold is as old and as well thumbed as his. In such a brotherhood as this, there can be only relatively minor differences in views of land and its life.

Yorke Edwards
30 March 1979

British Columbia Provincial Museum, Victoria, British Columbia V8V 1X4

Tribute to HOYES LLOYD, 1888–1978

Hoyes Lloyd, who died in his 89th year in Ottawa on 21 January 1978, was the central figure in Canadian nature conservation activities during the critical 25 years from 1918 to 1943. During that period, nature conservation grew from a personal interest in the minds of a few people to a responsibility taken seriously by government. The first person given a professional role in nature conservation by the Canadian Government, Lloyd carefully expanded and consolidated activities aimed at the conservation of migratory birds and of wildlife in the national parks and the Territories, laying the groundwork for the establishment of the Canadian Wildlife Service, which was formed (as the Dominion Wildlife Service) in 1947. His accomplishments rested upon his thorough knowledge of wildlife, his keen sense of what was possible and practical and, perhaps most importantly, his ability to pick a path through political and bureaucratic tangles with calmness, diligence, and humor.

For anyone of Hoyes Lloyd's generation, there was scant opportunity for a professional career in wildlife conservation. Almost all of those who broke into the field before 1930 were first obliged to seek means of livelihood less closely matched to their real interests. Lloyd, born in Hamilton in 1888, and educated at Harbord Collegiate Institute in Toronto and at the University of Toronto, found his first full-time employment in applied chemistry. From 1909 to 1911, while working for his Master's degree in Chemistry, he served as an assistant in the department, and during 1911 and 1912 he was employed by a manufacturer of chemicals. He entered public service in 1912 when he was appointed chemist in charge of milk control for the City of Toronto, and a few years later he played an important role in bringing about compulsory pasteurization of the city's milk supply. Not until 1918 was he able to give his full time to conservation.

But Lloyd was an active student of natural history long before that. Just after the turn of the century, he began to keep records of the occurrence and behavior of birds and to collect plants and birds. During the next few years he roamed the woods, fields, and marshes around Toronto, often with young friends who shared his interests, building up his knowledge of nature and through his collections establishing permanent records of the occurrence of birds and plants. In 1903 he happened on a copy of *The Auk* in a book store and learned that bird study was a serious thing pursued by serious persons. In 1904, 1905, and 1906 he won prizes for plant collections entered in the Canadian National Exhibition. In the summer of 1909, which he later described as one of the most exciting times of his life, he hiked and paddled the wilderness as a forest ranger and deputy game warden on the Temagami Forest Reserve. In the same year he won a gold medal at the Canadian National Exhibition for his collection of bird skins.

Full-time employment as a chemist in the field of public health from 1917 to 1918 did not diminish his activities as a field naturalist. During that period he continued to observe and collect. In 1916 he became an Associate Member of the American Ornithologists' Union and in 1917 he wrote "Ontario Bird Notes" his first paper for *The Auk*.

Lloyd's opportunity to work in the field he loved came as attitudes to nature and the use of natural resources began to change. Early in the century, a few North Americans began to see the folly of profligate use of resources. In Canada, the Commission on Conservation issued its series of thoughtful reports in the years 1910–1913. Among its recommendations was one that called for an agreement between Canada and the United States for the protection of migratory birds. Discussions and negotiations proceeded, leading to the signature of the Migratory Birds Convention in 1917, and the enactment of enabling legislation in Canada, the Migratory Birds Convention Act in 1918. Within the year Hoyes Lloyd won a competition to head the one-man Migratory Birds Unit in the Department of the Interior.

Lloyd remained with the Department of the Interior and its successor, the Department of Mines and Resources, for 25 years, in charge of a wildlife unit that was gradually given broader responsibilities but was always too small to meet its responsibilities to his satisfaction. The early years were particularly difficult: the task immense, the resources infinitesimal. At first Lloyd served as policy-maker, field man, chief clerk, and everything in between, but within three years he had a clerical assistant and three migratory bird officers to help him cover all of Canada. An urgent requirement then as now was to tell people about the Migratory Birds Convention Act, and the North West Game Act, for the administration of which he was also responsible, and to persuade them that the Acts and Regulations must be observed. This meant writing letters and leaflets; meeting sportsmen and naturalists formally and informally; advising teachers, wardens, police and magistrates; and conferring with officials of other government departments, provincial governments and the Government of the United States. It also meant travelling from one end of Canada to the other to familiarize himself with conservation problems in the field, of which there were many, and frequent meetings with his superiors

in Ottawa to seek more support for the work that had to be done. Progress was slow but steady. Migratory bird sanctuaries were established; the Migratory Bird Regulations were improved and their enforcement became more effective; cooperation with the United States in studying the migrations and populations of migratory birds was initiated and developed.

In 1922, Hoyes Lloyd organized and served as secretary to the first Federal-Provincial Wildlife Conference, an institution that soon came to meet annually and enabled effective exchange of information and views among the wildlife authorities of all the provinces and the federal government. The "Federal-Provincials," which are still held each year, have been highly effective in the development of wildlife conservation in Canada. At that first conference Lloyd no doubt displayed the capacity for unobtrusive but effective group leadership that he was later to employ so often in so many different settings. He was President of The Ottawa Field-Naturalists' Club from 1923 to 1925; President of the International Association of Game, Fish and Conservation Commissioners in 1929–30; Chairman of the Canadian Section of the International Council for Bird Preservation from 1927 to 1954 and Vice-President of the Council itself from 1938 to 1950. He regularly attended and, as the senior Canadian official, was often a key-note speaker at the annual meetings first known as the North American Game Conference (he was chairman in 1935) and now as the North American Wildlife and Natural Resources Conferences. He organized and chaired innumerable less formal meetings in many parts of Canada and in the United States.

By 1943 when Lloyd retired after 25 years of public service, wildlife protection in Canada was widely if not universally accepted and wildlife management as a more broadly based and purposeful discipline was beginning to emerge. Much of the credit for that development is his.

Retirement gave Hoyes Lloyd the opportunity to extend his professional interest in birds. This had not been neglected in his years in the Civil Service; he was increasingly active in the American Ornithologists' Union during the 1920s and 1930s and his bird collection slowly continued to grow. In 1942 he became a Vice-President of the Union and he served as its President from 1945 to 1948. His participation in the work of the International Council for Bird Preservation became more active in his post-retirement years during which he attended and contributed actively to each of its quadrennial conferences until 1972. All this work was, of course, voluntary; though he often represented the Canadian Government abroad in places such as Helsinki, Caracas, Bulawayo, and Tokyo, he paid his own way and he did so without complaint. Old associates in the American Ornithologists' Union and the Wildlife Society continued to welcome him to their meetings which he attended until 1973.

Even after travel became less easy for him Lloyd kept up an active correspondence with his many friends and received occasional contributions to his collections. His collections of plants, birds, and mammals along with his field journals covering a period of 71 years and his extensive library, are now in the care of the Royal Ontario Museum.

Hoyes Lloyd wrote over 120 papers and notes for publication. Of these, over 100 were contributions to *The Canadian Field-Naturalist;* he did much to develop its reputation as a worthy source of information about Canadian wildlife. In 1944 he published in our journal a 32-page annotated list "The Birds of Ottawa," which consolidated and added to notes on Ottawa birds published in 1923, 1924, 1925, 1932, 1936, and 1937. In 1945, 1949, and 1951 he again added to his regional list. This work provided a major reference for the bird group of The Ottawa Field-Naturalists' Club and contributed occurrence records to many later works on the distribution of North American birds. Lloyd's bibliography includes papers dealing with many other records of bird distribution in other parts of Canada as well as records of migrations derived from the recoveries of banded birds and accounts of the introduction of Ring-necked Pheasant and Hungarian Partridge to various parts of Canada.

The only Canadian to be the recipient of the two premier honors in the wildlife field in North America was Hoyes Lloyd. He was presented with the Leopold Award by the Wildlife Society in 1956 and the Seth Gordon Award by the International Association of Fish, Game and Conservation Commissioners in 1974. He was made an Honorary Member of both those organizations and he was elected a fellow of the American Ornithologists' Union and of the New York Zoological Society. He was an Honorary life member of the Quebec Zoological Society, the Outdoor Writers Association of America, and The Ottawa Field-Naturalists' Club.

Lloyd was married in 1913 to Wilmot Lockwood of Memphis, Tennessee. His two daughters and his son, and later his grandchildren and great-grandchildren all lived in Ottawa, and with his wife and himself formed a close-knit group that was rarely long separated. Their home in Rockcliffe Park, selected because he heard a Wood Thrush sing when he first inspected the spacious grounds, provided an ideal site for frequent family parties.

A warm and friendly person, unfailingly courteous, Hoyes Lloyd was always generous with his time and knowledge, particularly with younger people. It was often my personal pleasure to benefit from his counsel

Hoyes Lloyd

On the occasion of his receipt of the 1974 Seth Gordon Award, the highest honor given by the International Association of Game, Fish and Conservation Commissioners, for his outstanding work in wildlife conservation.

and encouragement. While he knew that the continuing progress of nature conservation would be well served by the help he gave to those who would take up his cause, his personal relationships went far beyond such mere calculation. He truly loved his fellow man.

DAVID A. MUNRO

IUCN (International Union for Conservation of Nature and Natural Resources), 1110 Morges, Switzerland.

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Compiled by V. M. HUMPHREYS

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News and Comment

Robert Lister Receives Award

The fourth Loran L. Goulden Memorial Award for outstanding work on natural history within the province of Alberta was awarded to Robert Lister at the annual meeting of the Edmonton Natural History Club on 9 January 1979. Bob Lister, Honourary President of the Edmonton Bird Club, served as an indispensible assistant to the late Prof. William Rowan for many years, while the latter conducted his world-renowned experiments on influence of photoperiod on migration; however, he is recognized in this award primarily for his long-term role in encouraging other naturalists in Alberta, through his newspaper column, his role in founding the Edmonton Bird Club, his social activities, and other means. His forthcoming book on the birds of Beaverhill Lake, based largely on Rowan's work, marks a fitting occasion on which to recognize Bob through this award. Further details on his career and a list of his publications will appear in a future issue of the *Alberta Naturalist.*

Martin K. McNicholl
Chairman, Loran L. Goulden Memorial
Award Selection Committee

Notice of Change to the By-laws of The Ottawa Field-Naturalists' Club

A motion to change By-law 15 of The Ottawa Field-Naturalists' Club was passed unanimously by the Council at the meeting of 12 February 1979. This By-law now reads as follows:

15. *Membership Dues*
The schedule of dues shall be as follows:

Individual	$10.00
Family	$12.00
Sustaining	$25.00

Life Membership shall be granted upon payment of a single sum of $200.00.

Diana R. Laubitz, Recording Secretary

Article or Note?

For *The Canadian Field-Naturalist* the assigning of an accepted manuscript to one category or the other is currently done solely on the basis of the manuscript's length. We do not differentiate Articles from Notes on the basis of the quality or importance of the observations or research, although these criteria are stated or implied for some other scientific journals.

Notes are run on one after the other so as not to be wasteful of available costly space because we are charged on a per page basis for every page that contains any printing whatsoever. Sometimes referees and editors request that authors condense their papers. The aim of the constructive advice is that the new information is presented as clearly and concisely as possible. Thus if an author focuses on the objectives of his or her study and the purpose of his or her report, the manuscript will be more succinct and its message more easily grasped.

Beginning with the 1977 issues, I eliminated the main difference between the earlier printed versions of Articles and Notes by starting to use the same basic format for both. With this issue I have further eliminated the previous difference in type sizes. Therefore, shorter papers will be published as Notes and longer ones as Articles but they will both be in the same format. No differentiation will be made by the Editor nor should be construed by authors or readers regarding the relative significance of the Notes as compared to Articles in *The Canadian Field-Naturalist.*

LORRAINE C. SMITH,
Editor

Notice of Motion to Amend the Constitution of The Ottawa Field-Naturalists' Club

Notice of a motion to amend the Constitution of The Ottawa Field-Naturalists' Club was received, in accordance with Article 23 of the Constitution, for presentation at the next Annual Business Meeting. It is proposed that: Article 11, now reading:

> "AUDITORS. Two Auditors shall be elected by open vote at the Annual Business Meeting. They shall examine the Treasurer's accounts and certify as to their correctness."

be amended to read as follows:

> AUDITOR. An Auditor shall be elected by open vote at the Annual Business Meeting. The Auditor shall examine the Treasurer's accounts and certify as to their correctness.

Motion proposed by Courtney Gilliatt, seconded by William Cody. This motion is in accordance with a recommendation made at the last annual meeting.

Diana R. Laubitz,
Recording Secretary

Request for Participants — International Shorebird Surveys 1979

A cooperative International Shorebird Survey scheme was organized by the Canadian Wildlife Service and the Manomet Bird Observatory in 1974 to obtain information on shorebird migration and to identify and document areas of major importance. Much very valuable information has come from contributors throughout eastern Canada and the USA, the Caribbean Islands, and Central and South America, and this is being used in assessing requirements for the future protection and conservation of the birds and their habitat. Continuation of the project is planned for 1979. Any observer who will participate in regular counts of shorebirds during migration periods, as well as during the winter in shorebird wintering areas, is asked to contact one of the undersigned. Occasional counts from observers visiting shorebird areas on an irregular basis would also be most welcome. For areas in Canada: *Dr. R. I. G. Morrison, Canadian Wildlife Service, 1725 Woodward Drive, Ottawa, Ontario, Canada K1G 3Z7.* For areas in USA, Caribbean Islands, Central and South America: *Brian A. Harrington, Manomet Bird Observatory, Manomet, Massachusetts, U.S.A. 02345.*

Request for Information — Shorebird Color-marking

In 1979 the Canadian Wildlife Service will be continuing a large-scale program of banding and color-marking shorebirds in James Bay. Since 1974 over 38500 shorebirds have been captured, resulting in more than 1700 'bird days' of sightings of dyed birds ranging from eastern Canada to South America. Considerable valuable information on migration routes and strategies is being obtained and observers are again asked to watch for and report any color-dyed *or* color-banded shorebirds. Reports should include details of species (with age if possible), place, date, color-marks and, if possible, notes on the numbers of other shorebirds present. For color-dyed birds, please record the color and area of the bird that was dyed. For color bands and standard metal leg bands, please record which leg the bands were on, whether they were above or below the "knee," the colors involved (yellow or light blue), and the relative position of the bands if more than one was on a leg (e.g., right lower leg, blue over metal, etc.). All reports will be acknowledged and should be sent to: *Dr. R. I. G. Morrison, Canadian Wildlife Service, 1725 Woodward Drive, Ottawa, Ontario, Canada K1G 3Z7.*

The Douglas Pimlott Scholarship in Environmental Studies

Innis College, University of Toronto, has established a scholarship fund in memory of Professor Douglas Pimlott, who for many years taught ecology, resource management, and environmental studies at the university. Among his many contributions, Dr. Pimlott established an Environmental Studies program, designed not for in-depth specialist training but in the spirit of a liberal education concerned with the environmental issues that face us all.

The scholarship will be awarded to an undergraduate student who, like Doug Pimlott in his own life, combines high academic achievement with dedicated social involvement in environmental concerns. It is hoped that sufficient funds can be raised to endow the award.

Contributions should be made payable to the Douglas Pimlott Fund, University of Toronto, and sent to: The Principal's Office, Innis College, 2 Sussex Avenue, Toronto, Ontario M5S 1J5.

Book Reviews

ZOOLOGY

Animals in Peril: a guide to the endangered species of Canada and the United States

By D. C. Grainger. 1978. MacMillan, Toronto. 192 pp., illus. $14.95.

This is another in a long line of books examining the plight of animals in North America. The title is misleading, however, because the book deals strictly with mammals. Furthermore, I do not see this book as "a guide to endangered animals of Canada and the United States." It is a slightly less than erudite review of twenty mammals exploited by man at one time or another since his arrival in North America from Europe. In fact, some of the mammals considered are no longer endangered, or have never appeared on an endangered species list.

The mammals considered include the Black-tailed Prairie Dog, Kaibab Squirrel, Spotted Bat, Fisher, Pine Marten, Black-footed Ferret, Sea Otter, Wolverine, Gray (timber) Wolf, Red Wolf, northern Kit Fox, Mountain Lion (eastern cougar), Grizzly Bear, Wood Bison, Muskox, Pronghorn Antelope, Florida Key Deer, Big Horn Sheep, Walrus, and the northern Manatee.

Grainger has geared his book for young readers or novice biologists. His treatment of habits, habitat, and life cycle biology is very rudimentary and often suffers from too much brevity.

The saving grace of this book is the author's treatment of the cause and effect relationships involved in the decline of some of these mammals. He examines the role man has played in their decline and documents efforts made to reverse the trend. For example, by 1940 there were only thirty Florida Key Deer left in existence, the result of overhunting. Interest in this small deer on behalf of the U.S. Fish and Wildlife Service, the Florida Game and Fresh Water Fish Commission and many conservative organizations, the National Audubon Society to name one, was instrumental in preventing its extinction. Land was set aside as refuge and today there are approximately 400 animals in existence. To this end, Grainger leaves his readers with a glint of optimism. Essentially, the book examines the history behind the environmental manipulation of 20 mammals, and the consequences of such action when poorly planned and executed.

The text is accented with color portraits and black line drawings of the mammals. A bibliography, although broad in scope, is provided for those who wish to continue on with the study of these mammals.

PAUL A. GRAY

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The Great Arc of the Wild Sheep

By James L. Clark. 1978. 4th Edition. University of Oklahoma Press, Norman. 247 pp. Paper US $11.50.

"Many are inclined to think of the wild sheep as just scattered here and there around the world with little reason — but this is not so. Although they are rather thinly dispersed, the sheep are confined to a relatively narrow arc of mountain ranges which sweep across three continents." *The Great Arc of the Wild Sheep* examines the wild sheep of the world.

"All wild sheep of the world may be divided into five general groups: moufloniforms of the Mediterranean Islands and Middle Eastern countries, Argalis or Ammons of Central Asia, Asiatic Bighorns of Eastern Siberia, Dall's of Alaska and Northern British Columbia, and North American Bighorns of western North America." Each species is treated separately with each treatment generally containing information on the species' physical features, its habitat requirements, and its distribution.

Scattered throughout the text are stories of hunting expeditions. Some of these hunting expeditions were mounted in an effort to collect specimens for museum collections; some merely hunting adventures.

The Great Arc of the Wild Sheep was first printed in 1964. This fouth edition does not include a great deal of new information over the first edition.

To enjoy this book, one must be truly interested in wild sheep.

PETER CROSKERY

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A Guide to the Birds of Venezuela

By Rodolphe Meyer de Schauensee and William H. Phelps, Jr. 1978. Princeton University Press, Princeton, New Jersey. xxii + 424 pp., illus. Cloth US $50.00; paper US $19.95.

The publication of this guide is a noteworthy addition to the ornithological literature of South America in that it summarizes in one volume descriptive, distributional, ecological, and taxonomic information about the 1296 species of birds known to have occurred in Venezuela.

The book comprises an introduction in which the Venezuelan avifauna is summarized too briefly (1½ page): the geographical and ecological features of the country are dealt with briefly also (4 pages). Travel to and in Venezuela is treated in a few words. A plan of the book and short comments about the illustrations conclude the section. A "Chart of a bird" and a "List of families of Venezuelan birds" follow.

The scope of the book is limited to Venezuela but nevertheless encompasses a very broad topic. The book, to quote an excerpt from the introduction, "contains a description of all the species of birds known at present to inhabit Venezuela and its adjacent islands...." Most of those species, except for some North American migrants, are depicted in the 53 plates assembled in the center of the book. A map of Venezuela appears on both inside covers and corresponds to geographical entities mentioned in the text.

Each family is introduced by a short paragraph in which are given general characteristics of the family, a short summary of the habitat preferences, other ecological facts, and general information of interest.

The information dealing with each species is short but factual. The authors have provided in addition to the scientific name, Spanish and English common names for all species. The latter are particularly well chosen and descriptive. Descriptions are given in telegraphic style and, to my knowledge, are accurate, at least for the 25–30 species that I have checked against specimens. Characteristic details peculiar to a species are sometimes given in italics and are provided for both sexes in species where sexual dimorphism is present. Total length and occasional measurements of certain body parts are provided (metric and imperial systems). Descriptions appear to be adequate for a large number of species but one wishes that more distinguishing features had been given for similar species. This would certainly be appreciated in the field. Zoogeographical data are contained in a short paragraph, while in addition to indicating the "life zone" of the species, it summarizes the range in Venezuela and in peripheral countries. The ecological and distributional data are necessarily brief but are adequate in orienting the observer in the field. In addition, this part often contains behavioral information as well as descriptions of calls or call notes.

Line drawings of an exceptional quality by Michel Kleinbaum supplement several descriptions. The other illustrations are grouped in the center of the book and "show virtually all of the resident species of birds found in Venezuela." Thirteen black-and-white plates (i–xiii) by Guy Tudor are of excellent quality and are particularly efficient in depicting raptors in flight.

The 40 color plates have been contributed by Tudor, Wayne Trimm, John Gwynne, and Kathleen Phelps. They are of very good quality in general but Tudor's are exceptional.

Field characters are given for each species opposite each plate, or in a few cases, on following pages where species are too numerous on a single plate. The layout is attractive and species have been arranged in a logical manner on the basis of similarities between them; this is undoubtedly the most practical approach to field identification. Of course, additional details on distinguishing characters appear in the textual descriptions, which can be located rapidly, the page number being indicated next to the species name. All illustrations should make it easy for the field observer to identify rapidly a large number of species, at least the males. Flycatchers will no doubt continue to be a nightmare!

A species list based on specimen records deals with the birds of Isla de Aves on page 369. Subspecies depicted in the illustrations are listed in an appendix, followed by a short bibliography, which should have more correctly been called "selected references." Indices to English and Spanish names, as well as to genera and species are given in the last pages of the book.

The cloth copy is not solidly bound and it appears that it may not resist intensive use in the field. Furthermore, the price of the cloth edition is very high in comparison with the paper edition and I wonder why hard covers alone cost $30.00 (USA)!

In spite of this shortcoming, this guide is the best available to date for South America, and the authors and artists are to be congratulated on their excellent work. I highly recommend the book to anyone interested in South American birds or planning to watch birds in northern South America.

HENRI OUELLET

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North American Moose

By Randolph L. Peterson. University of Toronto Press, Toronto. 280 pp., illus. Paper $13.50.

This book, first published in 1955, has been re-released in paperback. At the time the author did his research it represented the only serious long-term study on Moose in North America. It is still well worth reading, both for the uninitiated and for those of us actively working with this species. *North American Moose* presents a foundation on which biologists have built their knowledge of Moose. As a follow-up to this book and for a more recent compendium of the state-of-the-art on Moose, I recommend *Alces, Moose Ecology*, Les Presses de l'Université Laval, 1974.

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Wild Geese

By M. A. Ogilvie. Buteo Books, Vermillion, South Dakota. 340 pp., illus. US $25.

Recently there have been several books written dealing with waterfowl in a general manner (Johnsgard 1975; Bellrose 1976; Palmer 1976). Unlike these former works, "Wild Geese" deals only with geese, and on a world scale as opposed to one continent.

The format is considerably different from the usual and somewhat dreary collection of individual treatments by species. Instead, subjects are examined including classification, identification, ecology, breeding, population dynamics, migration, distribution, and status. Within this framework, the various species of geese are discussed. This tends to make the text flow in a manner that is pleasant to read. Also contributing to the ease with which this book may be read is the author's considerable talent in dealing with often highly technical material in a fashion readily understood by the amateur ornithologist. It is well-illustrated, by Carol Ogilvie, with color plates; the pen-and-ink sketches throughout are especially good.

The major criticism the reviewers had, of a general nature, was the tendency towards too much detail on certain subjects and limited coverage of others. For example, ringing (banding) notably of Pinkfeet, numbers in subpopulations, and molt migrations all received extensive discussion. On the other hand, behavior (other than during breeding), nutrition, and physiology perhaps should have been covered in greater detail. Bergmann's rule is mentioned in several locations. This rule is at best tenuous when applied to geese, a fact noted by the author on p. 121. Ross' Geese and Lesser Snow Geese do not illustrate the rule as stated (p. 25). Over 65 percent of Lesser Snow Geese breed south of most Ross' Geese. This discussion should have been limited or omitted altogether.

The book contains many small errors. Map 25 should include heavily used areas at James Bay and North Dakota. Snow Geese migrate directly to the Gulf of Mexico from James Bay, not Hudson Bay. Map 24 shows no migration out of areas 7 and 10 while some movement further south is known to occur. Ross' Geese, not using the west coast, winter primarily in Texas as well as Louisiana (Palmer 1976). Numbers of Canada Geese in the Mississippi Flyway are over 700 000 not 60 000 (Hanson 1974). Cap Tourmente has been used for closer to at least 500 than 400 years. North American waterfowl hunters do not have to report their kills. The second reviewer was surprised to see data quoted from his doctoral thesis, yet not referenced (Prevett 1973). Minor errors such as these can be expected in a book of this type, particularly when a British author tackles the North American waterfowl literature.

On the whole, this book is informative yet easy to read. The author has done an excellent job of compiling the extensive literature on geese into a straightforward concise work. We recommend it particularly for amateur ornithologists and biologists not familiar with geese. Biologists will especially appreciate the chapters on ecology and breeding.

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Crows of the World

By Derek Goodwin. 1976. Cornell University Press (Comstock), Ithaca, New York. 354 pp. US $28.50.

It is fitting that Goodwin should contribute this authoritative book on another of his favorite groups. He began work on the jay about 30 years ago, and his long tenure with the British Museum of Natural History has allowed him further opportunities to explore the fascinating crow family. His earlier work, *Pigeons and Doves of the World* (1967), has recently been reissued as a second edition (Cornell University Press, 1977). The style, a welcomed combination of scientific yet non-technical writing, is similar for the two books. Because it summarizes much of what is known and clearly shows what is unknown, it is an excellent reference for ornithologists yet is very readable for amateur naturalists.

The general format also is similar to his earlier work. It begins with four general chapters on nomenclature, adaptive radiation, plumage and coloration, and behavior. The 41-page behavior chapter discusses a myriad of behavioral characteristics and is especially interesting.

Detailed species accounts are given in Chapter 5. An introductory two-and-one-half pages of Chapter 5 provide an interesting account of man's relationships with corvids, touching upon their role in our folklore, legend, and literature; our feelings toward their predation on eggs and young of small birds; the crop damages they cause; and their use as food. Where species comprise a distinct group, an introductory preface of taxonomic relationships and habits is provided. Each of the 116 species is then covered in detail — description, field identification, distribution and habitat, feeding and general habits, nesting, voice, display and social behavior, other names, and a list of references. Length of the accounts varies from about one-half page for the Banggai Crow, Flores Crow, and Sumatran Tree Crow to over eight pages for such well-studied species as the jay and magpie. For several species, there is no information provided other than a description and range. The many "No information" statements should certainly spur young ornithologists to go "afield." As the author states, one of the book's purposes is to indicate what is not known. About one-fourth of the pages in the species accounts chapter deal with the 16 species occurring in Canada and the continental United States.

Robert Gillmore has done an excellent job illustrating many of the species with line-drawings. Three colored plates showing adults of 22 species and juveniles of 4 species are nicely done and show the variety of shapes, colors, and patterns within the Corvidae. Range maps are provided for each species. These are small, general, and do not give any indication of seasonal occurrence. Migration or movements, in general, is the only subject I feel is slighted in the entire book. I would suspect that because of their size, the maps may not be totally accurate nor reflect up-to-date distributions. No mention is made of the regular occurrence of the Brown Jay in south Texas. One other omission I noted was the absence of a discussion of hybridization in New World corvids, a rare but documented event. Common and scientific names are indexed following Chapter 5.

This fully referenced volume stands as an extremely useful and important contribution. I believe that all readers will attest to the accuracy of the author's statement that the crow family is a numerous, diverse, and successful group of passerine birds.

NOEL J. CUTRIGHT

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Life of the Harp Seal

By Fred Bruemmer. 1977. Optimum (Prentice-Hall, Toronto). 170 pp., illus. $25.

Fred Bruemmer has produced a very readable work on the life of the Harp Seal. His style is pleasant and flows easily as he provides accurate accounts of the environment, culture, social structure, and history of the Atlantic region where the sealing activity takes place. His descriptions of the ice-environment are especially good. His commentary on some aspects of the biology of the Harp Seal are at times insightful and competent. Sometimes, however, Bruemmer's scientific commentary is mixed with ethical considerations which seem out of place. For example in a discussion of the seal's underwater hearing ability, he points out that the seal is "as one with the sea, . . . but when she must leave the sea . . . then she and her kind are at the mercy of man." The text is ripe with anthropomorphic references to "sad and worried mothers" and "jealous mates" which might be forgiven as poetic licence. The cause of the seal is taken up with such emotion, however, that the reader is left to question whether Bruemmer is offering the promised clear and unbiased account of the life of the Harp Seal. Photographs are as important as the text

of this coffee-table-size book. Ninety-eight color and black-and-white photographs which range in size from 2×3 inches to double-page spreads are contained within the book's 155 pages and many of them are excellent, as is characteristic of the author's other books. But a seal pup, in various appealing poses, appears in 61 of these pictures, as if one animal had been photographed many times from different angles. Most of the photographs are technically good, but many are only fair. In the few underwater sequences detail is difficult to resolve, and the large plate on page 101 is upside down.

Federal fisheries scientists will be disappointed with Bruemmer's half-page comment on Harp Seal management. Most of it is cynical and disparaging, and refers to the maximum sustainable yield as the Holy Grail of management biologists. Bruemmer spends much more time describing the "interfering" activities of man (sealers, tourists, aircraft) in the seal's life.

Bruemmer's description of sensory functioning in Harp Seals includes an able discussion of much of the data on the vision of seals and how it relates to their behavior in air and under water. His descriptions of audition and of vibrissae functioning, however, are inaccurate and at times patently false. He states that the seal's audiogram in air is similar to, if not better than, that of the human. In fact, though seals can hear higher pitches than humans, they are at all frequencies less sensitive to quiet sounds. His suggestion that a seal could hear a man walking on the ice a mile away is unlikely when one considers the relative acoustic impedances of ice and water. As far as whisker functioning is concerned, his statement that seals use their vibrissae to detect changes in water pressure, or the "tap of water against blocks of ice pressed far beneath the floes," and his implication that the whiskers can perceive the turbulence of fish movements over some distance are totally unfounded. Current evidence indicates their vibrissae are not sensitive enough for this.

His confident elaboration about the sense of smell being the primary means by which mothers and pups identify each other, and his contention that mothers can recognize the call of their own pups is completely unwarranted since such hypotheses have never been tested. Similarly, to our knowledge, his statement that pups are able to locate their mother's teat by an increase in skin temperature in the area of the nipple is unsubstantiated. Also, he implies that the mothers initiate weaning; however evidence from Harbor Seals shows that pups wean themselves.

Bruemmer describes in some detail the navigational methods Harp Seals use to traverse the distance between Greenland and their breeding grounds. In fact, very little is understood about the way in which any seal species plots its course over long distances. In a similar vein he states without qualification that Harp Seals can stay submerged for at least thirty minutes and can dive to depths as great as 600 feet, when in fact these numbers were obtained from the Antarctic Weddell Seal.

In his discussion of the social behavior of Harp Seals, Bruemmer asserts that these animals are gregarious, and that during the breeding season the female, when hauled out on the ice maintains a "moveable territory" about herself that only her pup can encroach upon. These are probably reasonable hypotheses although they have not been directly investigated. In further descriptions of reproductive behavior, however, his portrayal of the events leading to copulation are at best misleading and at worst completely incorrect. He states that a single male emerges the victor of an often bloody battle, to mate on the ice with a willing female who has been wooed by an hour-long display. In reality, nearly all copulations occur in the water and therefore have rarely been witnessed. The only published under-ice observations of reproductive behavior in these animals suggest that the seals are probably promiscuous, the females engaging in sexual displays with many males. Furthermore, as is the case in most mammalian species, true "bloody" battle is the exception rather than the rule: agonistic behavior in this context has become ritualized. Bruemmer's description of an hour-long display on the part of the "victorious" male is the first such report.

For a decade Canadians have waited for an independent and unbiased commentary on the Harp Seal and its harvest. One might have expected Bruemmer to have provided it since he has produced a number of good works. Readers hoping to find enlightenment on this contentious issue will find this book a disappointment.

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BOTANY

Edible Garden Weeds of Canada

By A. F. Szczawinski and N. J. Turner. 1978. National Museums of Canada, Ottawa, Ontario. 184 pp. $8.95.

This book is the first of a four-book series on the edible wild plants of Canada slated to be fully published by 1980, under the auspices of the Canadian National Museum of Natural Sciences. In this context, *Edible Garden Weeds* gains a significance that it would not otherwise have.

The volume is published in paper wrappers with a wire binding that allows the book to lie flat open at any page, a desirable feature in any cookbook. And in fact, the great inspiration of this work is the combination of the "standard" cookbook format with the equally "standard" edible weeds or wild plants format. In our experience it stands alone amongst similar books on this count, other texts generally immersing recipes in a chatty dialogue with no comparable systematic layout of ingredients and instructions.

Pages are odd sized (approximately 21 × 21 cm) and, unfortunately, the use of space is wasteful; in fact *Edible Garden Weeds* stands alone in this regard also. The bulky size, and useless weight of many ½- to ⅔-full pages certainly makes the book of less use to "scouts, outdoorsmen, and others concerned with survival." We hope that this "spacious" format approach is dropped in other books of this series by the National Museum, for if it is carried through it will be no less than a slap in the face for conservation.

The main body of discussion of species and recipes is printed on white glossy paper with an attractive type style and a rather nice, very dark green ink. All other pages are of colored paper, brown in front and bright yellow at the back. The many line drawings are clear and crisp, and only rarely have the artists "fudged" the smaller details of the plants. Several color photos add a definite exciting touch to the book.

Actual contents of the text provide a good introduction to the edible weeds dealt with; however, we feel it is deficient and misleading in several specific and general instances. The fact that many areas where weeds grow prolifically have poisoned soil needs to be emphasized and re-emphasized, especially to a dominantly urban audience. This is a high paradox in this book, for while people are warned away from a few clearly edible species on rather slim grounds, no mention is made of the dangers of lead toxicity inherent in many an "unkempt boulevard." The plethora of dangerous industrial chemicals that today contaminate many rail rights-of-way, roadsides, and vacant lots is likewise unmentioned. As a general rule, any weeds growing near urban or industrial developments should be avoided, but in fairness *Edible Garden Weeds* is not alone in its lack of this warning.

Also, we wish that the nutritional virtues of weeds, when growing in uncontaminated sites, had been far more completely explored. Given the small number of species and species groups treated (about 40), wouldn't it have been possible to produce a more precise discussion of these virtues, and fill some of the waste space in the book with, say, distribution/abundance maps? Most of the text discussion is a reasonably complete "standard" description of plants, habitats, uses, etc., slightly modified better to fit the Canadian context, and clearly organized under headings.

The many recipes (about 130) without doubt contain the most controversial aspects of this book. They range from simple teas, salads, soups, and spreads to lunches and even rather exotic meals. On the one hand, the recipe layout and use of common "supermarket" ingredients will be attractive to many urban and suburban cooks. On the other hand, natural food buffs can object to over forty ingredients as chemical-ridden or simply "non-food" items. At least fifteen of these could readily have more natural or "real" foods substituted, and the complexity of some recipes should be questioned. A certain balance of nutrition and health seems to have been overlooked in the attempt to make "weeds" credible to the general cook.

This is not a book for the backwoods or farm, but rather seems designed for suburban or estate residential environments and tastes. The attempt seems to be to make "weeds" acceptable by associating them with heavily flavored and often exotic ingredients within a colorful, open and "artsy" publication style. Much information is presented, but in no way can the text be considered a critical analysis of the values and uses of edible weeds and it stands on relatively equal footing with several other easily available works. Any one who wishes to understand properly the value of edible weeds will still have to purchase a collection of several books, and in this context the acquisition and use of *Edible Garden Weeds of Canada* becomes a matter of personal taste.

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Ferns of the Ottawa District

By William J. Cody. 1978. Printing and Publishing, Supply and Services Canada, Hull, Quebec K1A 0S9. 112 pp. $3.25.

The revised edition of this book is quite delightful. There is a modern durable plastic binding with some attractive silhouettes on it and the printer has done a superb job with good modern clean type and the right mix of various sizes of bold-face type, italicized type, etc. By the clever use of dividing lines, the author has solved the problem of associating the figures, the text, and the distribution maps for each species. The illustrations of selected herbarium specimens are by and large the same as in the first edition of 1956, but because they are on glossy paper, have slightly less gray in the background and have a black line on three sides of the plate, they seem infinitely clearer, sharper, and more three dimensional. Another great improvement is the distribution maps, which are much larger in size and so crystal clear that one feels one could almost rush out to a given locality dot! The keys are simple and workable and the addition of five new species to the District (*Pellaea atropurpurea, P. glabella, Woodsia obtusa, W. oregana,* and *Asplenium platyneuron*) plus a plethora of new locality dots, e.g., *Ophioglossum* from 5 to 21, brings the revision right up to date. In these days of soaring book costs, this book is a tremendous bargain and should be purchased by anyone interested in ferns.

What are the shortcomings of this fine identification manual? Most of my criticisms are a plea for further information from authors. For example, consider the distribution maps. Do the dots each represent a herbarium specimen or do they represent all records known to the author? Should a distribution map represent the status of the species today or should it include historical records (*Dryopteris goldiana* now under a shopping mall)? What about sight records and specimens in private herbaria?

Next the taxonomy, which might be dubbed "authoritative conservative." Admitting that the names used are familiar ones and this manual is probably not a good vehicle for radical taxonomy, it still seems the author might include a statement of his philosophy, or even a plaintive disclaimer that he is a follower of, or influenced by, Gray's Manual, Britton and Brown, Wherry or whatever. It is most confusing to the amateur to see *Camptosorus* in this book and *Asplenium* in another; also *Athyrium* vs. *Diplazium*. Similarly, the Long Beech Fern can be found in *Thelypteris* or *Phegopteris* and as *P. polypodiodes* or *P. connectilis*. Fortunately the author has supplied a few synonyms for cross reference.

I do not like the treatment of *Dryopteris*, partly of course because of my personal bias and knowledge of the genus. I feel that there should be six species treated and not four and also wonder why *D. X boottii* is singled out as the one hybrid recognized for the district. The most common hybrid is alluded to on p. 70 (*D. X triploidea* Wherry). The common name, Florist's Fern for var. *spinulosa* (not *D. intermedia*) on p. 66 is most unfortunate. I cannot imagine a florist using this fern and would deplore the attempt!

Another point concerns the designation of *variety*. This seems to be a legacy of Gray's Manual. Surely if one is not going to recognize our Ostrich Fern as a distinct species, it is at least a subspecies? Some varieties seem a bit trivial or useless, e.g., *Botrychium matricariaefolium* var. *matricariaefolium, B. multifidum* var. *intermedium,* and *Polystichum braunii* var. *purshii,* whereas others such as *Dryopteris cristata* var. *clintoniana* are major biological species as shown by cytogenetics. I think a few references for the amateur who wishes to delve more deeply would be extremely worthwhile.

Amateurs are also apt to ask for the rationale of the sequence of genera as presented. Why is *Dennstaedtia* between *Polystichum* and *Athyrium*? If no grouping is intended, or no authority followed, then why not use an alphabetical approach?

Ideally it would be nice if authors were a bit more explicit about field characters or "tricks of the trade." How will you know a *Pellaea* when you see one, instantaneously? For instance, emphasis on indusial characters for *Cystopteris* and *Woodsia* when these are obscure on mature fronds confuses amateurs. I foresee difficulties for workers distinguishing between *Woodsia obtusa* and *Woodsia oregana* with the key.

A minor annoyance in manuals is the rather unspoken assumption that one can map a species for all time if one just carefully "covers the ground." This is far too static a concept for plant populations. Accordingly, when we are told under *Dennstaedtia,* "Large ferns in colonies" and then later "perhaps it is overlooked," I would prefer the idea that it is spreading and becoming more weedy in the district. Similarly, with *Asplenium platyneuron*, I doubt it was there until recently and will not be surprised if the locality dots increase in numbers very shortly.

I feel the author has done a most commendable job. What I am really saying is, give us *more* — more references, more explanations, more taxonomic philosophy, and we will gladly pay more!

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Dyes from Lichens and Plants: a Canadian dyer's guide

By Judith Waldner McGrath. 1977. Van Nostrand Reinhold, Toronto. 144 pp., illus. $14.95. Translated into Inutituut and syllabics.

How this book came to be written is as interesting as the information on dyes from native plants. Mrs. McGrath is a dyer, a weaver, a sculptor, and a teacher. In recent years she has lived in several northern settlements following her husband in his work with the Economic Development Council.

Spence's Bay, where the book was written, is a community of 400 people on the Boothia Peninsula, a tiny speck on the bleak arctic landscape when seen from the air. On arrival, it was a shock to find native people in modern clothes and living in ordinary homes, but as Mrs. McGrath made friends with the Inuit she recognized that cultural differences do exist.

In the brief arctic summer flowers bloom everywhere. Continual daylight encourages growth but high winds, lack of moisture, and occasional snow cause severe stress to the environment. Yet close to the ground, where the air is warmer, grow some 900 species of flowering plants and perhaps 1000 lichens. It was here that Mrs. McGrath began her search for dye stuffs. Each find was shared with her new friends. Soon an experimental workshop was set up, opened throughout the long winter night so that women could work when it was convenient. The following summer a grant made it possible to gather plants farther afield and to experiment with colors that could be obtained from them. To the Inuit women, used to bright commercial dyes, the new muted shades were exciting. Designs made from them won awards, and official parkas for the 1974 winter games were designed and made here. By 1977, when the McGraths left, the craft shop was becoming a co-operative — 32 people were involved in the new cottage industry.

Much of the book is devoted to the plants themselves, to the parts used and the amount of dye material needed for best results. It is impressive that from the beginning there was concern for the ease with which the fragile ecological balance could be destroyed. Spot collecting was done over a wide area. Only a part of each plant was taken, leaving some roots for propagation and some flowers to set seeds. Material was preserved by drying, by fast freezing of plants, or by preparing and freezing the dye bath. In all, 17 basic dye methods or recipes were evolved. Of these nine are for lichens, the rest for flowering plants, seaweeds, and mosses.

Few colors remain fast on fiber without the use of a mordant such as alum, iron nails, or copper. Mordants combine chemically with the dye and the fabric to fix the color. Variation in shade can be obtained by changing the mordant used or the time at which it is added. For the beginner the easiest plants are those with their own mordant such as sumac, which contains tannin, and the lichens which have their own acids.

There are chapters on the people and their crafts and on the land itself, brought to life by black-and-white photographs. Beautiful color plates illustrate groups of plants and display small tie samples of wool colors obtained from them. There are lists of useful equipment, of stores that carry supplies for dyers, an index of plants by colors they can produce, another of plants in more temperate parts of Canada that will produce comparable colors, and one giving botanical as well as common names. In preparing the book, government departments in both Ottawa and the Northwest Territories were consulted. Identification of all plants and lichens was confirmed at the National Herbarium.

My only complaint concerns the color plates. They are very attractively arranged and colors are good, but there is no explanation of the photographs. In this section, one finds only outlines of illustrations with difficult-to-decipher numbers and letters. These illustrations would be so much more useful in the part of the book where plants and dye colors are described.

Except for the difficulty with color plates the material is well and interestingly prepared. The author knows her subject and has been generous with that knowledge. Mrs. McGrath says that care in each step from washing of the fiber to mordanting and dyeing affects how well and evenly colors take. Don't worry about the experts; read them and listen to them, but the only sensible course is to experiment yourself.

Although the book is presumably intended for weavers and dyers, many people unfamiliar with the craft will find pleasure in it. The book is sturdily bound with an eye-catching jacket. It was written and published in Canada. Highly recommended.

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ENVIRONMENT

Human Activity and the Environment

By Statistics Canada. 1978. Statistics Canada, Ottawa. 190 pp., illus. Paper $2.80 in Canada; $3.40 elsewhere.

Statistics Canada has attempted to put together a "statistical series detailing human activities which have a potential for imposing stress on the natural environment." The resultant book has seven chapters which are entitled watersheds; agriculture; forests; fisheries; transportation; manufacturing; energy. It is an interesting and welcome initiative by Statistics Canada.

A novel section contains the presentation of certain social economic data by the natural physiographic unit of the watershed. All of Canada is delineated along the boundaries of the major, and some minor, watersheds. Some of the data given by these units include human population; watershed area; human population density; farms and farmlands fertilized, sprayed and irrigated; livestock numbers; and industrial activity.

Some interesting examples of data from the text are given below. The large increase in the sales of pest control products, which are also known to some of us as biocides, over the last 30 years is somewhat disturbing. Since 1971 the increase appears to take the shape of an exponential curve! Statistics Canada outlines the striking decline in the weight of fish taken by Canadians off Canada's shores from 1968 onward. The corresponding increase in landings by other nations, most notably the Soviet Union, provokes thought.

An attempt is made to make the text visually interesting. This attempt works reasonably well. One illustration which stands out is the complex map of noise contours around Toronto International Airport. The noise magnitudes are presented by various shades of blue. The many people that live in the area and are subject to the noise disturbances often see red on this issue.

The data presented is scattered in content and given uneven treatment. Nevertheless one must sympathize with the authors' considerable task of choosing subjects in such a broad field.

There are some obvious biases in a document of this kind. First, the environmental phenomena must be easily measurable and quantifiable. Second, there must be an existing measurement program underway. Most readers of this journal could easily think of many critical environmental issues that badly need methodological measurement. For example, human activities often put considerable stress on wildlife populations but usually we have only partial data on what population changes do occur.

Some classes of data that might be given consideration for future editions include the following:

1) The attitudes of Canadians towards the environment. Who cares? How much? About what?
2) The recreational pursuits of Canadians in terms of dollars and time spent.
3) Canadian land-use changes over time. The existing section in the book should be expanded.
4) Air quality data.
5) Water quality data.
6) Various wildlife populations data.

It must be kept in mind that this first attempt has broken considerable new ground. Hopefully, refinement and enlargement will take place with future editions.

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Vermilion Lakes Banff National Park: an introductory study

By the Bow Valley Naturalists. 1978. Bow Valley Naturalists, Banff, Alberta. 68 pp., illus. Paper $3.00.

The Vermilion Lakes area, immediately west of the town of Banff, in Banff National Park, has long been a focus of interest for visiting and resident naturalists. The lakes themselves are large, shallow ponds which (for the mountains) are highly productive aquatic systems. The view of the north end of Mount Rundle across the lakes is a famous and frequently photographed sight and has become almost synonymous with Banff.

The richness of the area, coupled with increased use by visitors and the threat of further impact by highway construction along the northern edge of the lakes has heightened concern for its future. This publication is, in part, an attempt to increase public awareness of the values of the Vermilion Lakes in the face of new pressures on them.

The study covers a range of cultural and natural history fields, each treated in a separate section and based on the field studies and research carried out by various members of the Bow Valley Naturalist Club in

the mid-1970s. A set of recommendations regarding the future use and development constraints on the lakes are made which result from an assessment of the data assembled during the study.

All of this is pulled together in a tight, attractive, paper-covered booklet which is effectively illustrated by line drawings, photographs, and maps. A somewhat cumbersome poem about the lakes starts it all off, and the booklet ends with a fairly extensive list of references. It is well put together, with clear easily readable type, crisp appropriate photographs and some excellent pen-and-ink drawings. In format and production it is a pleasing and effective document to deal with.

The study is intended to introduce the reader to the Vermilion Lakes. It does that quite admirably. I suppose my only major criticism is that the authors held themselves to this. Detailed flora and fauna data are not provided despite quite extensive studies in some of these fields. Appendices are maintained by the Bow Valley Naturalist which contain raw lists of the observations reported during the study period, but these are not easily accessible. In the booklet proper, only very general statements of status are included (e.g., "occasional in wet spruce forest" or "fairly common. Nests"). This *does* introduce the reader to the subject; it would have given him so much more if that extra effort had been made to pull these observational data together into precise, clearly documented discussions. It seems that making such statements as ... "The Cougar appears to be on the verge of extinction in Banff National Park," and the American Bittern ... "Must nest but no records," are quite inadequate without more supportive documentation and discussion.

A volunteer effort of this nature is very dependent on the quality and quantity of the individual effort contributed by concerned naturalists. Inevitably, the quality of content varies throughout in such an effort. The herpetological section, for example, is very strong, whereas the botanical material is not so. I understand that this latter area suffered considerably because of Parks Canada's unwillingness to provide a collecting permit for the study!

Although quite free of typographical errors, a number of spelling errors and omissions do occur (e.g., *Gallium* for *Galium*, incomplete scientific name for Alder Flycatcher, *Spirea* for *Spiraea*). These are infrequent enough, however, neither to affect seriously the credibility of the document nor greatly to impair its readability.

The Vermilion Lakes study is a fine effort by a number of concerned and dedicated naturalists who have obviously gone to considerable personal expense and effort to increase our awareness and appreciation of an important natural area in Banff National Park. I hope it inspires other groups to embark on similar ventures and I would certainly recommend it to those readers who would like to know more about Banff. I recommend it even more strongly to those of us who often feel that individuals and small groups of naturalists can't do much to document and publicize the values of an area which we cherish. The Bow Valley Naturalists have shown that it *can* be done and they are to be congratulated for their fine efforts.

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MISCELLANEOUS

Weather Almanac

Edited by J. A. Ruffner and F. E. Bair. 1977. 2nd edition. Gales, Detroit. 728 pp. US $25.

The *Weather Almanac* is useful to both the layman who is interested in weather phenomena and the technical people who use weather data in their jobs.

The section on "Weather Fundamentals" would be a better section to put first than the "Atlas Format Weather." I recommend that this section be read first to both interest and inform the reader.

I am slightly disappointed that the 1941–1970 tridecade was used for most tables when an upgrade using data from 1941–1976 is easily available from the weather service. This is especially important since new extremes were set in 1976 and 1977 and the almanac does not, therefore, explain the harsh winters for example.

The "Glossary of Weather Terms" is certainly useful as it explains in general terms most of the meteorologist's jargon.

The section on "Climates of the World" is very useful for travellers but lacks an overview of "Climate" in general. It would be better to put our present world climate into an historical perspective. We are presently in an abnormal period of climatic

history. We are coming to the end of an interglacial warm period and the tridecade data reflects only this period. Throughout most of the world's existence, the climate has been "glacial" and the fact that it is not now is both interesting and gives man a sense of the enormous impact of climate. This leads naturally into the "Health and Weather" section and the awareness that there are scientific relationships between health and the weather.

The descriptions and safety rules for "storms and severe weather" are clear and especially useful for self-protection in the winter. Folklore (such as p. 119) and rules of thumb (distance to storms, be your own forecaster) add immeasurably to the dry textual information. Earthquakes are not strictly speaking a weather phenomenon, but the tables do allow the reader in a specific area to review this phenomenon both historically and currently.

The section on "Air Pollution" and its effects (Table 5.2) is slightly misleading in that there is conflicting evidence on effects and levels of pollution at which they occur. Similarly Figure 5.14 does not cover the case of a plume that is hot enough to break through a weak inversion, thus trapping pollutants above it. In this case almost none of the pollutant comes down to the ground to affect receptors.

The section on "Energy and Weather" is an excellent introduction to the fundamentals of energy conservation for the days of restraint ahead.

The "Weather of Selected U.S. Cities" is a good general summary of climate information and is well documented and presented. The "Atlas Format Temperatures," on the other hand, is confusing and, because of the type size, almost unreadable. It would be more useful to have one map showing the climate station locations and tables of highs, lows, and averages. The "normal monthly precipitation and snowfall" maps give easy reference to the amount of rain and snow visually but the type is too small to read for quantitative information.

Although there are a few typographical errors in the text, on the whole the almanac would be a very useful addition to either a layman or weather scientist's library.

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Introduction to Mathematics for Life Scientists

By E. Batschelet. 1976. 2nd edition. Springer-Verlag, New York. 643 pp. Cloth US $27.60; paper US $11.95.

Most frequently, book reviewers possess some expertise in the subject area of the book they are reviewing. This review departs from that tradition. My mathematics is best described as shakey. For precisely this reason I feel qualified to recommend *Introduction to Mathematics for Life Scientists* as a study guide and reference book for those who feel uncomfortable with the steadily increasing number of non-linear functions, differential equations, and matrix operations to be encountered in the current literature.

To facilitate study the chapters are comprised of bite-sized sections with alternating theory and examples or applications. Most examples are from the recent literature and referencing is thorough throughout. Each chapter is concluded by a section of problems, graded in difficulty, with answers for odd-numbered ones.

Most commendably the author starts at the beginning with a review of basic algebra, a knowledge of which is all too often erroneously assumed by other texts of similar intent. Subsequently, linear, power, periodic, and logarithmic and exponential functions are dealt with. Chapters on 'limits' and 'differential and integral calculus' build up to a treatment of differential equations. Chapters on graphical methods and probability are essentially self-contained. On the other hand the chapter 'matrices and vectors' requires considerable familiarity with earlier sections of the book.

A detailed list of contents and a thorough index make this a book to which one can refer easily. The clear concise text constantly refers back to the precise place where a difficult concept or step, likely to be troublesome, was treated.

My own fruitful experiences with this book have led me to the opinion that it provides an excellent starting point for any biologist who feels restricted by lack of mathematical expertise.

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NEW TITLES

Zoology

Adventure of the stone man. 1978. By F. Hamerstrom. Illustrated by W. Kimber. F. Hamerstrom, Plainfield, Wisconsin. US $6.95 plus 50¢ postage.

Alaska whales and whaling. 1978. Alaska Geographic Volume 5, Number 4. Alaska Northwest, Anchorage. 144 pp., illus. US $11.95.

Animals in danger. 1979. By Joseph Lucas and Susan Hayes. Clarke Irwin, Toronto. Paper $5.95.

*__Biology of fishes.__ 1979. By Carl E. Bond. Saunders, Toronto. 514 pp., illus. $22.75.

Biology of insect eggs: Volume I, general biology; Volume II, the eggs of insect families; Volume III, indexes and bibliography. 1979. Pergamon, Elmsford, New York. cl500 pp., US $330.

Biology of Reptilia: Volume 7, ecology and behavior. 1977. Edited by A. C. Gans and D. W. Tinkle. Academic Press, New York. xvi + 720 pp., illus. US $60.60.

†**Birds of the Gainsborough-Lyleton Region (Saskatchewan and Manitoba).** 1979. By Richard W. Knapton. Special Publication Number 10. Saskatchewan Natural History Society, Regina. 72 pp. Paper $3.

Bird sounds and their meaning. 1977. By R. Jellis. British Broadcasting Corporation. 256 pp., illus. US $11.

The Bobcat of North America. 1978. By S. P. Young. University of Nebraska Press, Lincoln. xv + 193 pp. Cloth US $11.50; paper US $3.50.

†**Camel quest.** 1978. By Anne Innis Dagg. York Press, Toronto. 150 pp., illus.

Contrasts in behavior: adaptations in aquatic and terrestrial environments. 1979. Edited by E. S. Reese and F. J. Lighter. Wiley-Interscience, New York. 406 pp. US $27.50.

Field guide to the seashells of the world. 1978. By G. Linder. Translated from 1975 German edition by G. Vevers. Van Nostrand Reinhold, New York. 272 pp., illus. Cloth US $12.95; paper US $8.95.

†**Fossils of Ontario: Part 1, the trilobites.** 1979. By Rolf Ludvigsen. Royal Ontario Museum, Toronto. 96 pp., illus. $7.50.

†**General patterns of invertebrate development.** 1975. By Gary J. Brusca. Mad River Press, Eureka, California. 134 pp., illus.

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FOUNDED IN 1879

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Some New and Interesting Vascular Plant Records from Northern Ontario

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Locations and habitats are described for recent additions to the native arctic-subarctic flora of Ontario, and for selected subarctic species which had been previously known from only one or two sites. Additions to the provincial flora are *Agrostis borealis, Aster alpinus, Calamagrostis deschampsiodes, Carex bigelowii, Hierochloe alpina, Kobresia myosuroides, Luzula confusa, Minuartia groenlandica, Phyllodoce coerulea*, and *Vahlodea atropurpurea*. Comments are offered on the occurrence of more widespread species such as *Hierochloe pauciflora, Kobresia simpliciuscula, Pinguicula villosa, Agropyron violaceum, Ledum decumbens*, and arctic-subarctic species of the genus *Pedicularis*. *Cypripedium calceolus* var. *planipetalum* is also recorded.

Key Words: northern Ontario, vascular plants, arctic-subarctic, phytogeography, mapping, rare or restricted.

During fieldwork directed towards a compilation of the vascular flora of the Hudson Bay Lowland, over 350 different Ontario sites have been visited. Many species new to this flora have been documented. The most interesting group are those restricted to the Hudson Bay area. The purpose of this paper is to report and discuss these new records and the distributions of restricted species now recorded from significantly more sites, in order to provide a useful data base from which to speculate on the character and extent of Ontario's "maritime tundra."

Species Accounts

Agrostis borealis
Carex bigelowii
Hierochloe alpina
Luzula confusa
Minuartia groenlandica

Kenora District: 54°28′N, 84°54′W; summit of abruptly rising Precambrian instrusive cuesta west of Hawley Lake, Birch Hill. *Riley*, 29 July 1978. 54°18′N, 84°30′W; summit of abruptly rising Precambrian intrusive cuesta east of Aquatuk Lake, elevation 900+ ft. [275 m] asl *Riley*, 29 July 1978.

The Sutton Ridges are a discontinuous series of Precambrian outcrops of various elevations and exposures extending across the northeastern Hudson Bay Lowland from the Nowashe River watershed northwestward to within 20 km of the Hudson Bay coast just east of Winisk. These prominent outcrops (Figure 1) are Precambrian diabase-gabbro sills overlying sedimentary Precambrian rocks consisting of a lower dolomitic unit overlain by a unit consisting of iron formations, greywacke, and other materials (Bostock 1968). Two of the most prominent of these, Birch Hill and Aquatuk Lake, had open rock barren summits supporting arctic species characteristic of such Precambrian habitats in northern Quebec. Other outcrops, such as at the Sutton-Hawley Lakes Narrows and near the Hudson Bay coast (55°N, 84°43′W) apparently do not support such species, although the flora of the former includes arctic-subarctic species such as *Potentilla nivea* (known elsewhere in Ontario only from near the lower Shagamu River: *Sims 2258;* SSM, TRT) and from Cape Henrietta Maria (CAN) (Figure 1).

As well as providing suitably exposed upland outcrop habitat, these summits were the first islands to emerge from the postglacial Tyrrell Sea in the northeastern Lowland, about 6000 yr BP (Webber et al. 1970). As a result, they have been available to the long-distance dispersal of plants for a much longer period of time than any of the surrounding Lowland except for areas far to the south and west, where none of these species now persist.

Agrostis borealis (*Riley 9511, 9464*) is a circumpolar low arctic species characteristic of "dry rocky and turfy places on acid rock" (Porsild 1957) and of "late-snow-free areas" (Hultén 1968). It was mapped by Porsild (1964) from the northeastern Hudson Bay Lowland but without apparent voucher reference

FIGURE 1. The Sutton Ridges, a series of Precambrian outcrops penetrating the Paleozoic wetlands characteristic of the Hudson Bay Lowland. This Aquatuk Lake 'cuesta' has an elevation ca. 275 m asl.

(CAN, DAO, TRT) nor with any mention made of it in his northern Ontario fieldnotes (CAN). It is not included by Scoggan (1978) in the flora of Ontario. The specimens collected (CAN, TRT) are typically awned, with the narrow leaves of var. *borealis*. It is also known from a third Ontario location (55°N, 84°43′W: abandoned Mid-Canada Line radar station 510, occupying a small inlier of Precambrian diabase-gabbro rock; *Sims 2462A*, 10 August 1978 (SSMF, Xerox TRT)) (Figure 2).

Carex bigelowii (*Riley 9536, 9460*) (Figure 2) is an amphi-Atlantic member of an arctic circumpolar species complex (refer map, Hultén 1964), characteristic of dry tundra and rocky habitats. Although also mapped by Porsild (1964) from the northeastern Hudson Bay Lowland, Scoggan (1978) reports it absent from the Ontario flora. Again, no reference is made to it in Porsild's fieldnotes from northern Ontario (CAN), nor is it represented in major Ontario herbaria (CAN, DAO, TRT). The Birch Hill (CAN, TRT) and Aquatuk Lake (TRT) specimens are typical; collections from outcrop near the Hudson Bay coast (55°04′N, 84°50′W; *Riley 9666*, 31 July

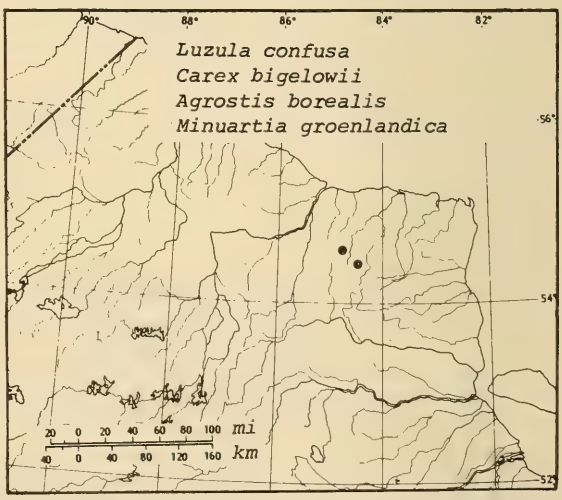

FIGURE 2. Ontario distribution of *Luzula confusa*, *Carex bigelowii*, *Agrostis borealis*, and *Minuartia groenlandica*.

1978 (TRT)) and from willow thickets near North Point, James Bay (51°28′N, 80°27′W; *Tessier,* 15 July 1976 (TRT), det. Ball) confirm Porsild's (1957) observation that the species' habit is "more lax in wetter sites" (Figure 2).

Hierochloe alpina (*Riley 9458*) was collected only on the summit of the outcrop at Aquatuk Lake (CAN, TRT) (Figure 3). Specimens collected belong to the subspecies *orthantha,* having untwisted awns attached above the middle of the second glume (Weimarck 1971). This taxon occurs from Greenland to the east coast of Hudson Bay and James Bay south to several mountain areas of New England and upper New York State. It reoccurs sporadically in Beringia, but this collection represents the western limit of its major range; the closest westward location, at Cape Churchill, is of ssp. *alpina.* This collection represents the first Ontario record of this circumpolar arctic-alpine species. John Macoun's reference (1888) to its occurrence at Moose Factory, James Bay, is unsubstantiated and highly improbable (Dutilly et al. 1954) (Figure 3).

Luzula confusa (*Riley 9512, 9467*) is a circumpolar arctic species, occurring southward in the Canadian Rockies and on a few mountain tops in New England, in dry turfy tundra heath, and on rocky slopes and ledges (Porsild 1957; Hultén 1968). These first Ontario records (TRT) complete the distributional gap between occurrences at Churchill, Manitoba and the northeastern shore of James Bay, Quebec (Figure 2).

Minuartia groenlandica (*Arenaria g.*) (*Riley 9526, 9471*), the attractive Greenland sandwort, is an eastern North American subarctic endemic, occurring from Greenland, southwestward through Newfoundland, Nova Scotia and in New England and northern New York State mountains, northwestward to the east coast of Hudson Bay north of James Bay, and now known as far westward as the Sutton Ridges in Ontario (for Quebec distribution, refer to Rousseau 1974). As with the other arctic-subarctic species disjunct on outcrop summits of the Sutton Ridges, the nearest major ranges of species are across the mouth of James Bay, in the Precambrian uplands of northern Quebec (Figure 2).

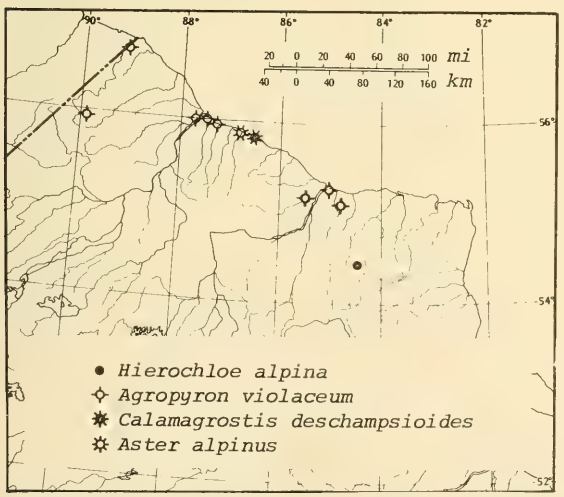

FIGURE 3. Ontario distribution of *Hierochloe alpina, Agropyron violaceum, Calamagrostis deschampsioides,* and *Aster alpinus.*

Agropyron violaceum (Hornem.) Lange (*A. latiglume* (Scribn. & Sm.) Rydb.)

Kenora District: Vicinity of the mouth of the Severn River. *Moir 1416,* 14 Aug. 1952 (CAN) (*sub A. trachycaulum* var. *novae-angliae;* rev. Porsild 1959).

Vicinity of the mouth of Goose Creek. *Moir,* 18–20 Aug. 1952 (CAN) (*sub A. t.* var. *n.-a.*; rev. Porsild).

15 mi [25 km] from the mouth of the Black Duck river. *Moir 2087,* 25–27 July 1953 (CAN) (*sub A. t.* var. *n.-a.*; rev. Porsild 1959).

56°00′N, 87°38′W; Fort Severn, near H.B.C. post. *Hustich 1256,* 28 July 1956 (CAN) (det. Porsild).

55°14′N, 85°05′W; Winisk, disturbed gravel-clay areas near airport. *Riley 5872,* 24 August 1976 (TRT).

55°14′N, 85°07′W, Winisk airport area, near fuel depot. *Riley 6140,* 26 August 1976 (TRT).

55°52′N, 86°46′W; coast of Hudson Bay, immediately east of mouth of Shagamu River. *Riley 7483,* 11 August 1977 (TRT).

55°57′N, 89°57′W; littoral habitat along Black Duck River. *Riley 8693b,* 19 July 1978 (TRT).

55°N, 84°43′W; abandoned Mid-Canada Line radar station 510. *Sims 2472,* 10 August 1978 (SSMF, TRT).

55°04′50″N, 85°39′30″W; upland thicket along river levee. *Sims 2130,* 23 July 1978 (SSMF, TRT).

This species, first reported for Ontario by Hustich (1957. Comparison of the flora and vegetation in the Fort Severn and in the Big Trout area. 2nd report concerning fieldwork in 1956. Arctic Institute of North America, University Library Tower, 2920-24th Ave., N.W., Calgary, Alberta), occurs north to Ellesmere Island and is transcontinental from Alaska to Greenland, south to northern Manitoba and Ungava; these specimens represent southern limits for this arctic species (refer map, Porsild 1964). None of the specimens seen have the pubescent glumes of the

more northern variety *hyperarcticum*. At Winisk it occurs in disturbed gravel areas, having colonized them since the air base was built in the 1950s. The other locations are from riverbanks of major spring-flooding rivers, in habitats such as low shrub willow thickets (*Riley 7483;* Hustich 1957) and graminoid meadows. Such calcareous alluvial sites are among the most floristically rich in the coastal area of southwestern Hudson Bay; the author has recorded up to 60 species within 30 m of closed and open low willow thickets along the lower Shagamu River (Figure 3).

Aster alpinus

Kenora District: 55°52′N, 86°46′W; coast of Hudson Bay, mouth of Shagamu River. *Riley 6972*, 29 July 1977 (CAN, TRT).

This improbable find was made among the gravel bars at the mouth of the Shagamu River, where it grew with such species as *Chrysanthemum bipinnatum* ssp. *huronense, Epilobium latifolium,* and *Elymus mollis*. It represents the first record of the species between the Great Slave Lake area and the Pyrenees in Europe. The North American phase, ssp. *vierhapperi,* is widely distributed in the Rocky Mountains through to Siberia (refer map, Hultén 1968) (Figure 3).

Calamagrostis deschampsioides

Kenora District; 55°44′10″N, 86°19′55″W; SW coast of Hudson Bay, about 15 km SW of the Shagamu River mouth. *Sims 2245,* 28 July 1978 (SSMF, TRT).

This Ontario record for this subarctic circumpolar coastline species helps to confirm its distribution around Hudson Bay, filling a gap between Churchill and York Factory, Manitoba (Scoggan 1957), and northern James Bay and Hudson Bay, Quebec (Rousseau 1974; Hultén 1968). It was found in a brackish marsh dominated by *Carex aquatilis* and *Scirpus hudsonianus,* about 0.5 km above the high-tide level, in peat 38 cm deep (Figure 3).

Cypripedium calceolus var. *planipetalum*

Kenora District: 52°57′30″N, 83°10′W; limestone outcropping across the Attawapiskat River about 40 mi [65 km] upstream of Attawapiskat townsite. *Riley 6328,* 3 July 1977 (TRT).

52°52′N, 83°45′W; northward facing limestone outcrop . . . along south shore Attawapiskat River. *Riley 6573b,* 5 July 1977 (TRT).

This variety was first described by Fernald (1926) from "turfy limestone barrens," "peaty . . . limestone barrens," etc., in northwestern Newfoundland. It was distinguished by its broad and short sepal, broad flattish petals, and a more cordate staminodium. Luer (1975) recognizes the taxon, although his distribution map inexplicably extends its range from Newfoundland up the St. Lawrence River to eastern Ontario.

It was found growing in open limestone White Spruce (*Picea glauca*) forest along the lower Attawapiskat River, associated with *Juniperus horizontalis, J. communis, Alnus crispa,* and *Arctostaphylos uva-ursi*. In the second site, it was found close to var. *pubescens* (Willd.) Corr. It is suggested that the status of this taxon requires closer consideration, especially in sites in which it is sympatric with other intraspecific taxa.

Hierochloe pauciflora

Kenora District: 54°40′N; 34 mi [55 km] au sud du cap Henrietta Maria. *Dutilly, Lepage 31411,* 17–18 August 1953. (Dutilly et al. 1954).

55°07′N; Cap Henrietta Maria. *Dutilly, Lepage 31124,* 10 August 1953. (Dutilly et al. 1954).

55°52′N, 86°48′W; mouth of Shagamu River, two miles inland, one mile west of river. *Riley 7294, 3 August 1977 (TRT).*

56°47′N, 88°53′W; West Pen Island. *Riley 8438,* 16 July 1978 (TRT).

55°N, 82°18′W; Cape Henrietta Maria. *Riley 9292,* 27 July 1978 (TRT).

55°14′N, 84°49′10″W; SW coast of Hudson Bay, approx. 10 km E of Winisk, 1.25 km from coast. *Sims 2417,* 9 August 1978 (SSMF, Xerox TRT).

This high arctic species (Porsild 1957), circumpolar except for Greenland and Scandinavia, is a wet tundra associate. Porsild's observation (1957), that the species is, "although not littoral, a distinctly coastal and lowland species," is apparently true along Ontario's Hudson Bay coast. It is found in mossy inter-ridge tundra situations, such as at Cape Henrietta Maria, and in inter-ridge mossy willow thickets.

It appears to achieve highest dominance values in open graminoid fen-meadows close to the coast with high pH values (6.2 and 7.2 recorded) and shallow peats (30 to 45 cm over permafrost or silts). One collection (*Riley 8438*) was made in a graminoid association dominated by *Calamagrostis stricta,* with *Hierochloe pauciflora* having cover value approaching 10%. Other species present at this site included *Carex rariflora, Pedicularis sudetica, Salix candida, S. brachycarpa,* and *Saxifraga hirculus* (Figure 4).

Kobresia myosuroides (Vill.) Fiori & Paol. (*K. bellardii* (All.) Degl.)

Kenora District: 55°52′N, 86°46′W; coast of Hudson Bay, immediately east of mouth of Shagamu River. *Riley 7480b,* 11 August 1977 (TRT).

55°22′35″N, 85°22′50″W; SW coast of Hudson Bay approx. 7 km NW of Winisk, 2 km from

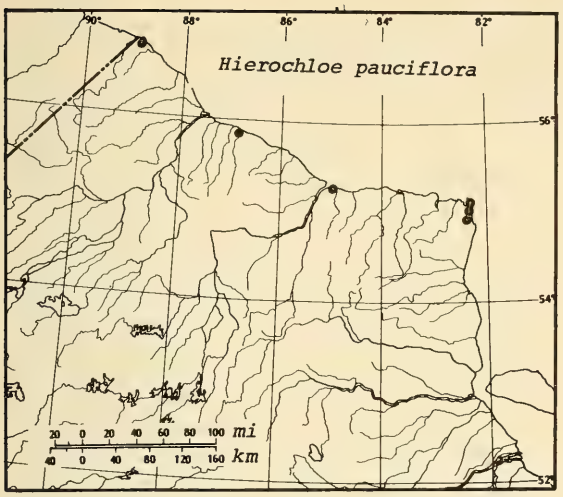

FIGURE 4. Ontario distribution of *Hierochloe pauciflora.*

coast. *Sims 2180b* (mixed coll'n with *Carex bicolor* All.), 26 July 1978 (TRT).

Easily overlooked, this tiny sedge is undoubtedly more widespread along Ontario's Hudson Bay coast. A circumpolar arctic-subalpine species occurring to northernmost Ellesmere Island, it is "a pronounced calciphile, preferring dry, sandy heath and windswept ridges" (Porsild 1957). The Shagamu River collection was from a silted, riparian low willow thicket association, while the Winisk collection was from an immature low shrub thicket with shallow peat (7 cm), and a dense graminoid ground cover including *Carex microglochin, C. rariflora, C. capillaris, Scirpus cespitosa,* and *Kobresia simpliciuscula* (Figure 5).

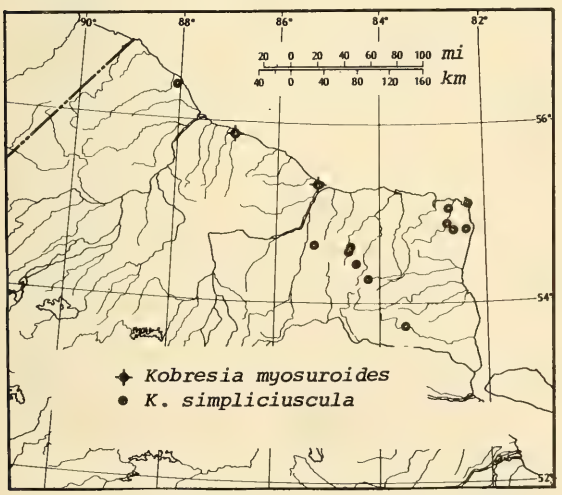

FIGURE 5. Ontario distribution of *Kobresia myosuroides* and *K. simpliciuscula.*

Kobresia simpliciuscula

Kenora District: 55°07′N; Cap Henrietta Maria. *Dutilly, Lepage 31135,* 10 August 1953 (Dutilly et al. 1954).

54°34′N, 84°38′W; Hawley Lake, *Sjors,* 1961 (Lepage 1966).

54°48′N, 82°23′W; Runway 415, south of Cape Henrietta Maria, *Riley 5850,* 23 August 1976 (TRT).

56°22′N, 88°08′W. *Riley 8465,* 16 July 1978 (TRT).

55°29′10″N, 85°41′15″W; SW coast of Hudson Bay, approx. 16 km NW of Winisk, 7.25 km from coast. *Sims 2043,* 20 July 1978 (SSMF, TRT).

55°22′35″N, 85°22′50″W; SW coast of Hudson Bay, approx. 7 km NW of Winisk, 2 km from coast. *Sims 2182, 2185,* 26 July 1978 (SSMF, (TRT).

55°02′N, 82°41′W. *Riley 9169,* 27 July 1978 (TRT).

54°47′N, 82°39′W. *Riley 9358,* 28 July 1978 (TRT).

54°50′N, 82°46′W. *Riley 9372,* 28 July 1978 (TRT).

55°12′N, 84°17′W. *Riley 9401,* 29 July 1978 (TRT).

54°19′N, 84°30′W. *Riley 9476,* 29 July 1978 (TRT).

54°38′N, 84°37′W; slope of Sutton River about 1 km from the river. *Riley 9567,* 29 July 1978 (TRT).

54°38′N, 85°20′W. *Riley 9631,* 30 June 1978 (TRT).

53°38′N, 83°29′W. *Riley 9737,* 3 August 1978 (TRT).

The distribution in Ontario (Figure 5) of this circumpolar arctic-alpine sedge is much more widespread than indicated by the few early records. The dozen subsequent records are all from calcareous habitats; six were made from open graminoid or open low shrub fens with pH's between 5.8 and 7.2, peat depths from 7 to 50 cm. These fen sites all had a vascular plant ground cover dominated by *Scirpus cespitosa,* with *Carex rariflora, C. livida, C. limosa, Betula glandulifera, Juniperus horizontalis,* and *Myrica gale* as common associates. The most common bryophytes recorded were *Scorpidium scorpoides, Tomenthypnum nitens,* and *Drepanocladus* spp. The non-wetland sites in which *Kobresia simpliciuscula* occurs include a variety of ericaceous tundra heath, frost-shattered limestone, frost-sorted till, and algal marl habitats not uncommon through the interior of the Hudson Bay Lowland in an area extending from the lower Ekwan River to the lower Winisk, northeastward to Cape Henrietta Maria.

Current studies in such interior areas confirm that terrestrial arctic habitats are not confined simply to a narrow coastal strip but extend to non-arboreal terrestrial (usually till upland or bedrock outcrop) habitats over a much wider area.

Phyllodoce coerulea

Kenora District: 55°07′N, 83°52′35″W; SW coast of Hudson Bay approx. 6 km SW of Sutton River mouth, 16 km from coast. *Sims 2397a,* 4 August 1978 (SSMF, TRT).

The closest records of this circumpolar subarctic-alpine mountain heather are from Cape Jones, Quebec (Rousseau 1974) to the east and from the Precambrian Shield of northern Manitoba to the west (Scoggan 1957; Ritchie 1962). It was collected from an upland open White Spruce–lichen woodland, with trees reaching 15 m (230 yr old), shallow lichen peat (less than 10 cm), and a water table ca. 50 cm deep. Lichen woodland on such beachridge complexes appears to burn regularly; those supporting forests older than 200 yr should be considered very rare (Figure 6).

Cody (1953) mapped and discussed its North American distribution and concluded that *P. coerulea* has widely re-occupied its glaciated northeastern range. Its occurrence 16 km from the Hudson Bay coast suggests a maximum age for the migration of the species into Ontario. The site is estimated to have undergone postglacial isostatic uplift over the last 1000 yr of about 1.2 m per century, and to have been above sea level for only about 1500 yr (Webber et al. 1970).

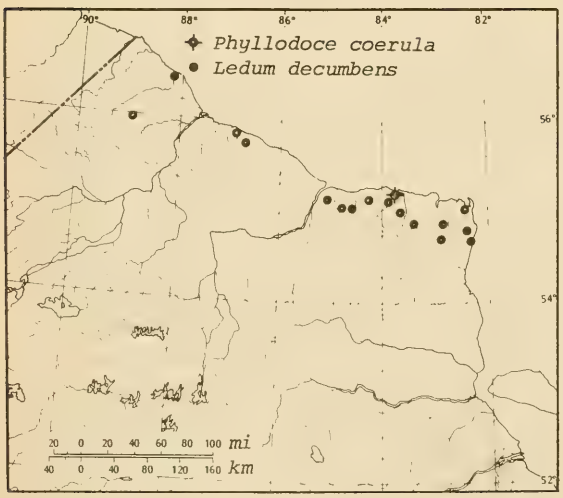

FIGURE 6. Ontario distribution of *Phyllodoce coerula* and *Ledum decumbens.*

Pinguicula villosa

Kenora District: 54°34′N, 84°38′W; Hawley Lake, *Sjors,* 1961 (Lepage 1966).

56°16′N, 88°05′W. *Riley 8478,* 16 July 1978 (TRT).

56°48′N, 88°52′W. *Riley 8485,* 16 July 1978 (TRT).

55°48′N, 87°31′W. *Riley 9042,* 23 July 1978 (TRT).

55°20′05″N, 85°39′15″W; approx. 12 km W of Winisk, 17 km from coast. Sims 2089, 13 July 1978 (SSMF, TRT) (*sub. P. vulgaris*).

55°11′N, 85°40′W. *Riley 9142,* 26 July 1978 (TRT).

54°28′N, 84°54′W. Birch Hill. *Riley 9513,* 29 July 1978 (TRT).

54°38′N, 85°20′W. *Riley 9633,* 30 July 1978 (TRT).

This circumpolar subarctic butterwort is not an infrequent acidophile of the fen and bog wetlands developing well back of the Hudson Bay coast (Figure 7). Within open graminoid fen patterns of the lowlands, it is found on bog (sphagnum) hummocks, palsas or on the bog 'laggs' or 'bibs' of peat plateau patterns. On the summit of Birch Hill, it was found growing beside a confined wet sphagnum pool.

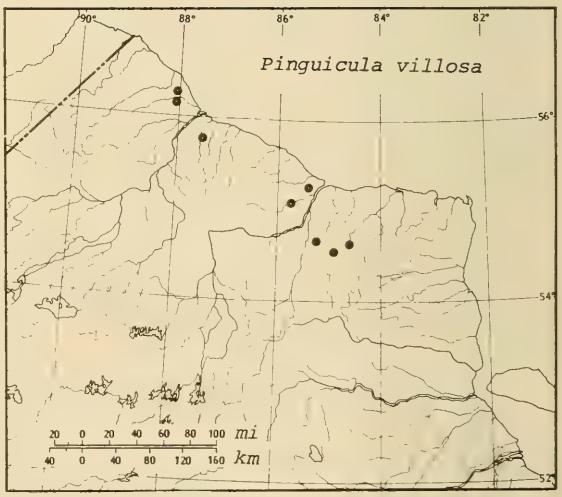

FIGURE 7. Ontario distribution of *Pinguicula villosa.*

Vahlodea atropurpurea

Kenora District: 55°07′N, 83°52′35″W; SW coast of Hudson Bay approximately 6 km Sw of Sutton River mouth, 16 km from coast. *Sims 2397,* 4 August 1978 (SSMF, Xerox TRT) (det. Reznicek).

This subarctic circumpolar grass is known as a rare tundra species in Manitoba (Scoggan 1957, 1978) and

a widespread species of Quebec's alpine meadows and open conifer forests on sandy soils (Rousseau 1974). This first Ontario record is from an open White Spruce–lichen woodland site also supporting *Phyllodoce coerulea* (see further site comments with that species) (Figure 6). This specimen is of the typical, eastern variety.

Recent field work in the Hudson Bay Lowland of Ontario has thus resulted in the addition of 10 vascular plant species to the provincial flora. These are *Agrostis borealis, Carex bigelowii, Hierochloe alpina, Luzula confusa, Minuartia groenlandica, Vahlodea atropurpurea, Aster alpinus, Calamagrostis deschampsioides, Kobresia myosuroides,* and *Phyllodoce coerulea.* The first five of these species are reported from the highest and most exposed of the outcrop summits of the Precambrian Sutton Ridges. Other than their nearly complete inaccessibility, these two stations do not currently enjoy any protective status. The other species are all from widely dispersed locations and, with the exception of *Cypripedium calceolus* var. *planipetalum* (lower Attawapiskat River), all are now known from sites within the Polar Bear Provincial Wilderness Park.

Discussion

All of the species reported here as new to the provincial flora should be included in the listing of rare vascular plants (Argus and White 1977). Of the other taxa discussed or mapped, *Pinguicula villosa, Pedicularis labradorica,* and *Cypripedium calceolus* var. *planipetalum* should also be listed as rare. Because of the rarity of suitable habitat in Ontario, it appears that some species are undoubtedly rare: *Agrostis borealis, Carex bigelowii, Hierochloe alpina, Luzula confusa, Minuartia groenlandica, Phyllodoce coerulea, Aster alpinus, Cypripedium calceolus* var. *planipetalum.* Others are widespread but regionally restricted: *Pedicularis* spp., *Ledum decumbens, Agropyron violaceum, Kobresia simpliciuscula, Pinguicula villosa.* Some are species of greatly undersampled habitats: *Hierochloe pauciflora, Calamagrostis deschampsioides, Kobresia myosuroides.*

In light of the currently accepted rough equivalence between a 'regionally restricted' status and a 'provincially rare' status, a caution may be in order. The "narrow band of tundra along the Hudson Bay coast" (Argus and White 1977) differs from the Carolinian zone (Ontario's southern zone of coincident restricted species) in that its wildlife remains largely intact, continuous and unendangered, and in that its geographic extent remains largely undefined, but almost certainly far larger than the Carolinian zone of southwestern Ontario. Mapping of most of Ontario's arctic-subarctic species confirms a 'maritime tundra' concept of Ontario's Hudson Bay shore (Figure 4, *Hierochloe pauciflora;* Figure 8, *Pedicularis* spp.). The distributions of species such as *Kobresia simpliciuscula* (Figure 5), *Pinguicula villosa* (Figure 7), and *Ledum decumbens* (Figure 6), however, indicate a much expanded zone.

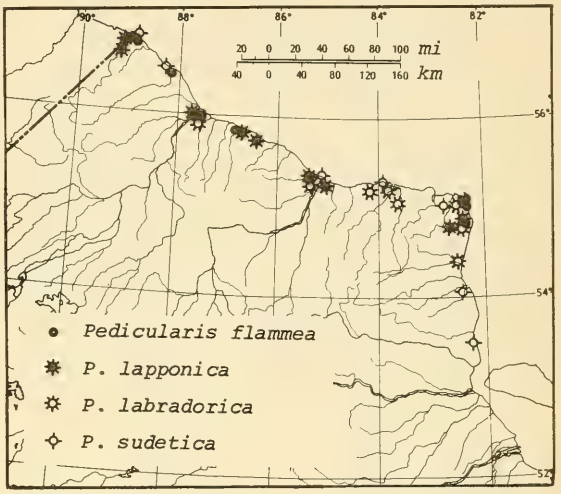

FIGURE 8. Ontario distribution of *Pedicularis flammea, P. lapponica, P. labradorica,* and *P. sudetica.*

Ritchie (1962) considered the subarctic zone in Manitoba to be characterized by a vegetation of primarily open conifer forest or a mixture of forest and tundra, and by a climate with a growing season not over 650 degree-days Centigrade and with a mean July temperature not over 14° C. This included all of the Hudson Bay Lowland in Manitoba, as well as the Precambrian Shield westward. Meteorological data from extreme northern Ontario are not presently of sufficient detail to delimit such a climatic zone. The 'openness' of Hudson Bay Lowland associations is not a function of dominant lichen woodland associations or of tundra thinning forest sites, but the result of the overwhelming dominance of wetland or peatland vegetation on clay-silt marine substrates. Zonal mapping by winter satellite photography (Hare and Ritchie 1972) shows the Hudson Bay Lowland to have albedo levels higher than, or comparable to woodlands, but this is not a result of any 'openness' of terrestrial systems. For similar reasons, the standard latitudinal zones, as summarized by Scoggan (1978), are not valuable in proposing boundaries for an arctic-subarctic floristic province in northern Ontario. As the collected floristic data base is completed, it is hoped that floristic criteria themselves will define such a zone.

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Mapping is based on specimens at CAN, DAO, SSMF, and TRT (1978), and on records as indicated in the text. J. M. Gillett (CAN) and W. J. Cody (DAO) kindly checked herbarium specimens and the field notes of A. E. Porsild (CAN) for references to the species new to Ontario. P. W. Ball of Erindale Campus, University of Toronto, assisted with the identification of some sedge specimens, and J. McNeill of the Biosysematics Research Institute, Agriculture Canada, verified determinations of *Agropyron violaceum*. Review of an earlier draft by R. A. Sims and J. H. Soper was very much appreciated.

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Yearly Variations in the Population Dynamics of Richardson's Ground Squirrels

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Population fluctuations were followed from 1975 to 1978 in a group of *Spermophilus richardsonii* in southern Alberta. Adult males ranged widely in early spring but they restricted the extent of their activities once all females were mated, and consequently fewer males were located on the study area after the breeding season than in early spring. Adult females made only minor changes in the location of their ranges from year to year and the major loss of adult females occurred overwinter. Each year fewer juveniles entered the active population than expected from the number of resident females and their reproductive potential. There was net juvenile immigration in the year with the lowest initial density and net juvenile loss in the years with highest density. Both predation and dispersal contributed to juvenile losses, particularly of males in 1976. The adult sex ratio favored females regardless of the sex ratio of the juvenile population in the previous fall. Telemetric studies are required to distinguish mortality in late summer from entry underground to hibernate and to distinguish death underground during winter from early emergence in spring followed by dispersal or death.

Key Words: Ground squirrels, *Spermophilus richardsonii,* dispersal, overwinter mortality, sex ratio, population dynamics, annual variations.

Large scale mark-release-recapture studies, by Dorrance (1974), Michener and Michener (1977), and Schmutz et al. (1979), of the population dynamics of Richardson's Ground Squirrels, *Spermophilus richardsonii,* have revealed that there is high loss of squirrels between years, that male losses are greater than female losses, that juvenile losses exceed adult losses, and that the adult sex ratio is biased in favor of females. Discrepancies exist between these workers in accounting for both the magnitude of losses and the differential nature of losses. Dorrance (1974) concluded that overwinter mortality and loss of pups prior to weaning were the main determinants of population size, whereas differential mortality favoring adult females in early spring and favoring juvenile females in fall and winter contributed to the biased adult sex ratio. Michener and Michener (1977) concluded that overwinter mortality was a major factor accounting for both the extent of interyear losses and the differential nature of losses in their population. Schmutz et al. (1979) concluded that overwinter mortality, while reducing population size, did not account for the disparate sex ratio but that predation, differentially directed toward dispersing adult males in spring and dispersing juvenile males in summer, did.

The aim of this study was to examine the population dynamics of a small group of individually identifiable squirrels by observation and trapping at more frequent intervals than used in previous studies in an attempt to distinguish residents from transients, to follow the fate of each resident squirrel, and to compare the results obtained by this method with those of previous studies.

Methods

The Richardson's Ground Squirrel population was located on fescue grassland in Fire Guard Coulee (50°34′N, 114°18′W, elevation 1235 m) 5.5 km NW of Longview, Alberta. An area of 0.72 ha was gridded with flags at 20-m intervals, and a record was kept of the identity and numbers of squirrels, and of their location within this area. Squirrels were individually marked with a numbered metal tag in each ear and with black dye marks on the fur. As part of a behavioral study conducted in 1975 all squirrels caught that year were further identified with a colored plastic disc attached to one ear tag.

Following initial trapping, which began on 13 April 1975, the squirrels on the area were observed for 147 h on 55 d between 5 May and 11 October; in general, squirrels were retrapped only when redying of the identifying marks was necessary. In 1976, squirrels were observed for 32 h on 13 d between 28 March and 4 July. Thereafter, the area was trapped at approximately 2-wk intervals until 11 October to determine which squirrels were still resident. In 1977 and 1978, all data were collected by trapping at approximately 10-d intervals between 20 March and 2 October, and 19 March and 24 April, respectively. Under the observation regime the area was surveyed 5 times an hour for approximately 3 continuous hours, and all active squirrels were identified by their colored disc and dye marks. Under the trapping regime an attempt

was made to capture every squirrel present; in 1976 this was done by placing an additional dye mark on each captured squirrel until all squirrels were so marked, and in 1977 and 1978 captured squirrels were held in the live-traps until no other squirrels remained active. As there were relatively few adult squirrels, all of which could also be identified without capture, errors in determining the number of residents were likely only within the juvenile cohort. Juveniles were sometimes not caught during one trapping episode but captured during the next one; such animals were assumed to have been in continuous residence and were included in the population count for the day on which they were not caught. On average, such 'missed' squirrels accounted for less than 8% of the juvenile population present during any trapping episode. Squirrels adjacent to the study area were trapped on a sporadic basis each year.

Except where otherwise indicated, the term 'resident' refers to a squirrel present on the area for a minimum of 2 wk, whose major burrow system was within the boundaries of the area, and which spent the majority of its active time on any day within the area.

Results

Adults

Adult males trapped in spring could be classed into three categories: transients which were present for at most a day or two before moving off the area, temporary residents which were present on the area for at least a week but did not remain resident for the summer, and permanent residents which remained on the area beyond the breeding season. Table 1 indicates the yearly residency status of each male classed, in at least one year, as a permanent resident or as a temporary resident. In the 4 yr of this study there was only one instance of an adult male remaining as a permanent resident in 2 consecutive years and one instance of a male born on the area remaining resident as a yearling. Three other yearlings that had been born on the area were recovered; one was classed as a transient in 1976 and two as temporary residents in 1977. Although at least half of the males classed as permanent residents had moved on to the area in early spring, there were no instances of adult male immigration during the remainder of the active season.

TABLE 1—Yearly residency status of adult males classed as permanent or temporary residents in at least one year (see text for criteria of classification). For those males also caught as juveniles their status as a juvenile is given

	Residency status			
Male	1975	1976	1977	1978
RO	permanent			
RB	permanent			
RBSS	permanent			
6201	temporary			
6210	temporary			
LW	transient	temporary		
LB		temporary		
LR		temporary		
RR		permanent	temporary	
LY	born on area	permanent	transient	
LG	born adjacent*	permanent	permanent	
RBSH		transient	permanent	
LPSS		born on area	temporary	
STS		born on area	temporary	
6404			temporary	
72		born off area*	transient	temporary†
6418			transient	temporary
6477				temporary
6462			born adjacent #	permanent†
6487				permanent
Total adults				
Permanent	3	3	2	2
Temporary	2	3	4	3

*Immigrated on to study area as a juvenile.
†Alive in 1979.
#Immigrated on to study area as an adult in 1978.

All losses of permanently resident males during the summer were attributed to entry into hibernation either because the males were recovered the following year, or because they became progressively fatter and less active, confining their movements to smaller areas in the days immediately preceding their disappearance.

After their emergence from hibernation, there were always more resident females than males (Tables 1 and 2). Females did not exhibit a pattern of spring movement and temporary residence, and all adult females were resident on or near the study area, either as juveniles or adults, in the previous year (Table 2).

Of the 11 original adult females resident in 1975, 10 remained for the summer, hibernated on the area, and reappeared in 1976. On 3 June a Badger (*Taxidea taxus*) invaded the main burrow system of the 11th female and she was not subsequently seen. A neighboring, non-lactating female whose range was adjacent to the study area extended her area to include part of that formerly used by the missing female. This female was not recovered in 1976.

Fourteen of the 15 females resident in 1976 remained through April and May and produced litters. The missing female, when last captured on 8 April, had a scarred face, weighed 210 g compared with an average of 276 ± 29 g for eight other females caught that day, and probably died in mid-April. Of the remaining 14 residents, six were recovered in 1977 and must have hibernated on the area. Four other females disappeared at a similar time to those that were recovered and apparently hibernated, but did not survive over winter. Four females disappeared in June, too early to have gone into hibernation on the area.

Of the 12 females resident in 1977, 11 remained on the area until the time of entry into hibernation, and five of these were recovered in 1978. The 12th animal, born on the area in 1975, disappeared in late May when her pups were about 3 wk old. Death rather than dispersal is the most likely explanation for her disappearance during the lactation period. All seven females resident in 1978 were still present when this study ended on 24 April.

TABLE 2—Composition of the population of adult females resident on the study area each year

Origin	Number resident			
	1975	1976	1977	1978
Resident on area 1975	11	10	3	0
Born on area 1975		5	2*	1
Born on area 1976			6	3
Born on area 1977				0
Born adjacent 1975†				1
Resident adjacent 1976†			1	1
Resident adjacent 1977†				1
Total permanent residents	11	15	12	7

*A third 2-yr-old was recovered but she established residency adjacent to the study area.

†Females in these categories were captured at least once within 40 m of the study area prior to the year they became resident on the study area.

The number of adults hibernating on the area was similar in each year: 3 males and 11 females in 1975, 3 males and 10 females in 1976, and 2 males and 11 females in 1977. Recovery rates in the following spring varied: in 1976, 0 males and 10 females were recovered, in 1977, 3 males and 6 females, and in 1978, 0 males and 5 females.

Juveniles

The numbers of adult female squirrels that remained on the area throughout the breeding, gestation, and lactation periods were 10, 14, and 11 for 1975, 1976, and 1977, respectively. Of these 9, 14, and 8 respectively gave birth, and 6, 12, and 7 reared at least one pup to weaning age. I attributed the complete and partial losses of four litters in 1975 to Long-tailed Weasel (*Mustela frenata*) predation because I saw a weasel hunting in the natal burrow systems of the mothers of these litters. Two of the mothers subsequently extended their ranges and spent less time in the area of the natal burrow, behavior patterns normally seen after the young are weaned (Michener 1979a), and they reared no young. The other two weaned only one young each. Such losses contributed to the smaller size of emerged litters in 1975.

Average litter size ± SD (range; N)
1975 2.5 ± 1.5 (1–5; 6)
1976 4.4 ± 1.5 (1–6; 11)
1977 4.0 ± 0.6 (3–5; 7)

The average litter size at birth for females captured when pregnant from the surrounding grassland in 1976 was 4.9 ± 1.0 (3–6; 15) (Michener 1977), suggesting a loss of 0.5 young per litter from field litters in 1976 during the 30 d between birth and weaning. No attempt was made to estimate in-burrow losses of the 1977 litters.

Because 1976 had both the largest number of females rearing litters and the largest emerged litter size, the number of juveniles reared on the area that year was greater than in 1975 and 1977 (Figure 1). There were 48 juveniles (28 males and 20 females) in the 11 of the 12 litters for which adequate data were available, compared with 15 (7 males and 8 females) in 1975 and 28 (13 males, 13 females, 2 unknown) in 1977.

In 1975 only one of the 15 juveniles born on the area failed to remain resident until fall; on 14 July I killed a

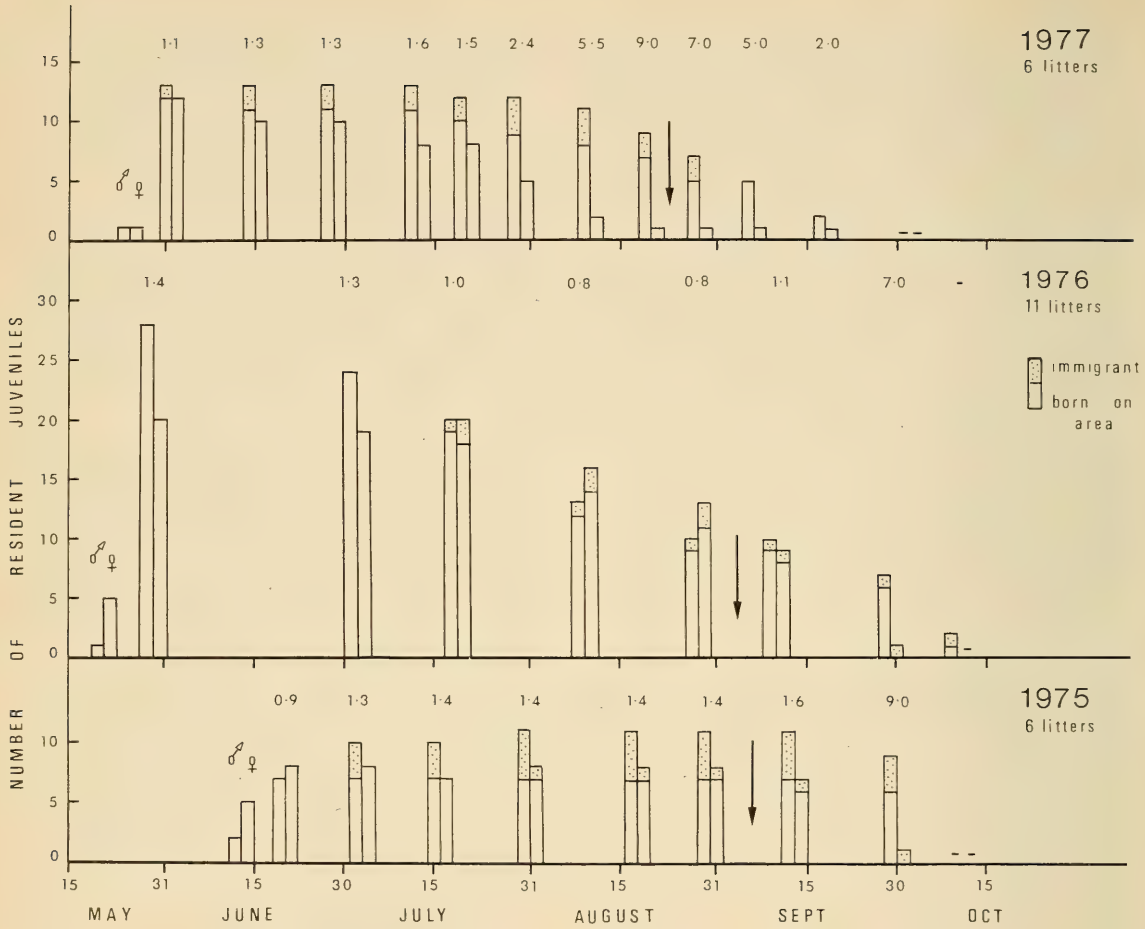

FIGURE 1. Numbers of juvenile males (left bar) and juvenile females (right bar) resident on the area in 1975, 1976, and 1977. The sex ratio (males per female) is given above each pair of bars. The arrows indicate the time in each year at which juveniles first began leaving the population to hibernate.

female that had severe myiasis of the neck and shoulder due to *Sarcophaga citellivora* maggot infestation. The remaining juveniles disappeared in mid- and late September (Figure 1) but only five females and two males were subsequently recovered as yearlings in 1976.

Of the 28 male and 20 female juveniles born on the area in 1976 none of the 19 males and 9 females that disappeared before 28 August was recovered in 1977. I assume that these losses were due to death or dispersal and that the pre-hibernation population consisted of those juveniles still resident on 28 August. There was only one accountable loss: I killed a juvenile male with *Sarcophaga citellivora* myiasis of the leg on 12 August. The initial sex ratio at litter emergence in 1976 was male-biased (Figure 1), but male loss was greater than female loss, particularly during July and early August when males were lost at a rate of $0.31 \cdot d^{-1}$ compared with $0.13 \cdot d^{-1}$ for females. By mid-August the sex ratio was female-biased and remained so until juveniles began entering hibernation. Of the 9 males and 11 females resident after 28 August two and six, respectively, were recovered in 1977.

Losses from the 28 juveniles that emerged on the area in 1977 commenced with the disappearance of four young, comprising an entire litter, between their emergence on 25 May and my next visit on 29 May. Because the mother remained resident at the same location, discounting the possibility of removal of her litter to a new burrow, and because juveniles 30 to 33 d old are unlikely to disperse, these young probably had died. A further three males and seven females

disappeared by the end of July. One of these males when last captured on 12 July had a swollen tongue, showed labored breathing, weighed 160 g compared with 223 ± 28 g for nine other juvenile males captured that day, and presumably died. Because none of the juveniles born in 1977 was recovered as a yearling in 1978, I could not attribute disappearance in late summer to immergence as opposed to death or dispersal for any individual. Assuming that immergence did not commence before mid-August, at most one female and seven males hibernated on the area. Thus there was a total loss of at least 6 males, 12 females, and 2 newly emerged young of undetermined sex.

Each year juveniles appeared that had not been born to resident females. If they used a burrow system on the area for at least 2 wk they were classed as resident immigrants (Figure 1). There were more immigrant juveniles in 1975, the year with the lowest squirrel density, than in 1976 or 1977. Of the five males and one female classed as immigrants in 1975, three of the males were known to have been born to females that were resident immediately adjacent to the area. Their appearance on the area may therefore reflect selective use of the mother's total range rather than true dispersal away from the natal area. Inadequate information is available on the other immigrants to determine whether any had moved over a large distance. Transient juveniles were also seen each year; some were caught several times over the summer and were probably nearby residents making excursions.

Causes of Loss

Disappearance of a ground squirrel could be due to three factors: death, dispersal, or entry into hibernation. Usually cause of loss could be accurately given only for those squirrels which reappeared the next spring; they left the active population and hibernated. In this study, of the 32 adult females, 8 adult males, 22 juvenile females, and 30 juvenile males resident (including immigrants) at the time of entry into hibernation, 21 (66%), 3 (38%), 12 (55%), and 6 (20%), respectively, were recovered the following year, indicating that greater male than female loss occurred between the time the first squirrel in each cohort disappeared underground and the time the last squirrel in each cohort reappeared in spring. I believe that the majority of the missing animals died after they left the active population to hibernate. Because some males were already active in 1976 and 1977 when the area was first visited in the spring, more males may have survived the hibernation period but moved off the area. A suspected, though not verified, source of mortality during the hibernation phase was predation by terrestrial predators, particular Badgers, on torpid squirrels over the several-month period between immergence and freezing of the soil. Extensive Badger digging on the study area occurred between 13 September and 28 October 1975, and between 28 August and 10 October 1976. Such predation could be age or sex selective if there are any differences in the quality or depth of hibernacula used by adults and juveniles or by males and females.

A possible source of mortality of adult males during early spring was intraspecific fighting. Once females emerged from hibernation the frequency and extent of wounds on the lower back, legs, and shoulders of males increased; I do not know whether the damage was inflicted by other males or by females. Such wounding associated with the weight loss males normally undergo during the breeding season could result in death, directly or through susceptibility to disease and predation.

Of the 7 adult females, 22 juvenile females, 25 juvenile males, and 2 juveniles of unknown sex lost during the active season, two were known deaths (killed because of *Sarcophaga citellivora* infestation) and three were suspected deaths due to Badger predation or poor health. None of the remaining 5 adults and 48 juveniles that disappeared during the summer was subsequently recovered and cause of disappearance was not known for any of them.

Some losses to predators undoubtedly occurred. I saw Long-tailed Weasels, Badgers, and Coyotes (*Canis latrans*) on the study area on 19%, 11%, and 15% of the days I spent there and I found 0, 13, and 17 scats in 1975, 1976, and 1977 respectively. Twelve of the 13 scats found in 1976 and 13 of the 17 found in 1977 contained the remains of Richardson's Ground Squirrels. Although these remains may not have come from squirrels on the study area, they do indicate that Richardson's Ground Squirrels are a usual source of prey for these predators. Red-tailed Hawks (*Buteo jamaicensis*), Swainson's Hawks (*B. swainsoni*), and Golden Eagles (*Aquila chrysaetos*) were often sighted and Bald Eagles (*Haliaeetus leucocephalus*) were seen every spring during their northward migration. One hawk pellet found on the area in 1976 contained the remains of an adult squirrel. In 1976 one carcass and in 1977 two carcasses were found on the area; there were insufficient remains to verify the cause of death or whether these were resident squirrels.

I assume that some of the losses over the active season were due to dispersal but, with the exception of four adult males that were not summer residents but were captured on the area in two consecutive springs, there were no verified cases of dispersal from the area. Dispersal onto the area occurred but often involved only a small-scale movement of a nearby resident. Of 4 adult females, 3 juvenile females, and 10 juvenile males that moved onto the area 4, 0, and 3

respectively were known to have been previously resident within 50 m of the area. Four of the seven males classed as permanent residents in 1976, 1977, and 1978 had not been resident the previous year and thus had immigrated in spring.

Discussion

The adult sex ratio among Richardson's Ground Squirrels is biased in favor of females (Nellis 1969; Sheppard 1972; Michener and Michener 1977) but virtually all females are bred (Michener 1974), indicating that males range over an area sufficient to encounter three or four females during the breeding season. Although Yeaton (1972) stated that male Richardson's Ground Squirrels established territories in spring that encompass the burrows of three to five females, implying exclusive access to those females, he neither defined his use of the term territory nor his method of determining territorial size and boundaries. From my observations of squirrels in early spring of 1976 I found that the ranges (see Michener 1979a for details of calculating range size) of each of the six males classed as temporary or permanent residents overlapped not only with the ranges of at least five females but also with the ranges of at least two males, while the ranges of the females overlapped the ranges of between two and five males. Apparently no male had exclusive access to any female. Because females are bred soon after emergence in spring, exclusive access may occur if males make day-to-day variations in their ranges relative to the location of receptive females.

This study indicated that in spring males remained on the study area for periods ranging from a few hours to several days to the entire season. Because of the presence of transients and temporarily resident males, more males were trapped in early spring than subsequently established residency within the area. If males had not been classed according to their status on the area, trapping data alone would have revealed male loss in spring suggesting differential mortality favoring females, as reported by Dorrance (1974) and Schmutz et al. (1979). The size of the ranges occupied by males declined after the breeding season (Michener 1979a) because of a decrease in the length and frequency of movements made by males. Although some loss of males in spring was probably due to mortality, the 'loss' of at least seven males that were transients or temporary residents was related to this decrease in movements resulting in a smaller range that no longer overlapped the study area. By the time females began giving birth no further changes in range usage by males occurred and all males still present remained as summer residents. Adult males that had been born on the area also changed their residency status with respect to the study area within any one breeding season and between consecutive breeding seasons. Because female Richardson's Ground Squirrels remain in the same area over several years one effect of male movement in spring is to reduce the amount of inbreeding.

This study confirmed previous observations (Yeaton 1972; Michener 1979a) that adult females, including yearlings, make only small-scale changes in the location of their ranges between years and within years. Female losses from the area during the active season were low in 1975 and 1977, and were attributed to mortality. In 1976, however, four adult females disappeared in June. The period immediately after lactation would be most suitable for dispersal of adult females; dispersal during the breeding, gestation, or lactation periods would be disadvantageous to successful rearing of a litter, and dispersal later in the summer would interfere with the weight gain that follows weaning of the litter and might not allow sufficient time to locate a suitable hibernation burrow. This study and those of Dorrance (1974) and Michener and Michener (1977), however, have found no evidence for dispersal by adult females. The higher recovery rate of females hibernating over 1975–1976 (91%) compared with 1976–1977 (60%) and 1977–1978 (45%) may be related to the higher proportion of females raising no young or only one young in 1975. Weather conditions unsuitable for feeding in the late summer of 1976 and the more severe winter over 1977–1978 (Michener 1979b), combined with the demands of rearing larger litters in 1976 and 1977, probably contributed to the reduced survival in the 1976–1977 and 1977–1978 winters. Whatever the causes, mortality during the overwinter period does appear to be the main factor affecting the size of the population of adult female Richardson's Ground Squirrels.

Each year fewer juveniles emerged than expected on the basis of the reproductive potential of the population, and there was greater between-year variation in the size of the juvenile population at emergence than expected from the differences in the number of adult females resident each spring. Normally 100% of yearlings and older females are successfully bred, and between 90% and 100% lactate (Nellis 1969; Sheppard 1972; Michener 1974; this study in 1975, 1976, and 1978); the unexplained failure of three yearlings to produce litters in 1977 reduced the potential juvenile population by about 12. Comparison of litter size at birth (Michener 1977) or in utero (Schmutz 1977) with size of field litters at emergence indicates that there is usually a small loss from most litters. Predation on litters by weasels, however, caused major losses and largely accounted for the appearance of only 15 juveniles in 1975 when about 36 were expected from the number of resident lactating females.

There was a net incease of juveniles between emergence from the natal burrow and the time of entry into hibernation in 1975 but net loss in the other two years. In 1975 no juveniles left the area, suggesting that there are densities below which dispersal does not occur, but the immigration rate was highest, indicating that dispersal can affect the size of the juvenile population. Although indirect evidence suggests that terrestrial predators took a larger number of squirrels in the years with the highest squirrel densities, I could not estimate the magnitude of losses or determine whether such losses were sex-related. Luttich et al. (1970) reported that the sex ratio of juvenile Richardson's Ground Squirrels killed by Red-tailed Hawks approached equality, whereas Schmutz et al. (1979) found that Swainson's Hawks and Ferruginous Hawks (*Buteo regalis*) captured disproportionately more juvenile males. I believe that a combination of dispersal and predation accounted for the majority of losses of juvenile males in 1976 and 1977. Male loss exceeding female loss, as in 1976, has previously been reported for juvenile Richardson's Ground Squirrels (Dorrance 1974; Schmutz et al. 1979) and other hibernating ground squirrels (Rongstad 1965; McCarley 1966; Slade and Balph 1974; Morton et al. 1974; Dunford 1977). Greater loss of females is unusual and I do not know why 90% of juvenile females disappeared in the summer of 1977. With the exception of females in 1977 the major loss of juveniles from the area and the major immigration of juveniles onto the area occurred during July, as in the studies by Dorrance (1974) and Schmutz (1977), suggesting that there is a minimum age juveniles attain before dispersing and that dispersal is completed at least a month before hibernation commences.

Although the sex ratio (males per female) among juveniles in the pre-hibernation population varied from 1.4 in 1975, to 0.8 in 1976, to 9.0 in 1977, the sex ratio among yearlings recovered was female-biased in 1976 (0.6) and 1977 (0.4); with no recoveries in 1978, suggesting greater loss of males than females overwinter. Mortality occurring at the end of the active season, however, when juvenile males were predominant in the active population, or at the beginning of the next active season, when adult males predominantly constituted the active population, would also affect the sex ratio. Schmutz et al. (1979) considered that mortality, mainly due to predation by migrating avian predators, at these times was significant in readjusting the sex ratio, whereas Michener and Michener (1977) believed overwinter mortality to be more important in the readjustment. Laboratory studies of hibernating sciurids show that there are basic differences between males and females, with males having lower survival rates, longer bouts of continuous torpor but a shorter hibernation season, and a greater likelihood of permanently arousing when stressed or disturbed during hibernation (Twente and Twente 1967; Morrison and Galster 1975; Pengelley et al. 1978), so higher mortality of males during the hibernation phase is a possibility.

As with previously reported studies (Dorrance 1974; Michener and Michener 1977; Schmutz et al. 1979) of Richardson's Ground Squirrels I found that there was high inter-year loss of squirrels, with male losses exceeding female losses and juvenile losses exceeding adult losses, and that adult female squirrels rarely dispersed, with the major loss from this cohort occurring over winter. Here I have indicated that observation or trapping at frequent intervals during early spring is necessary to reveal the residency status of adult males. The contraction in size of range used by a male once all females are bred contributes to the apparent loss of adult males from a local area. Some losses result, not from dispersal or predation, but from the male confining his activity to a smaller range outside the study area and thus being overlooked. I found, as did Dorrance (1974), that variations in the overwinter survival of females and in the extent of loss of pups prior to weaning determined the density of the population in mid-summer. Michener and Michener (1977) predicted that when the adult female population is small or the reproductive success of females is low, there will be no juvenile dispersal. In this study weasel predation, reducing juvenile addition to the population, resulted in the lack of dispersal of juveniles from the area in 1975. The size of the population of adults in spring and of juveniles in summer varied each year as a result of these interactions between overwinter survival, reproductive success, predation, and dispersal.

Discrepancies among Dorrance (1974), Michener and Michener (1977), Schmutz et al. (1979), and this study in accounting for the greater losses of both adult and juvenile males compared with females can, in part, be attributed to variations in the populations under investigation. Populations located in aspen parkland (Dorrance 1974) and on short-grass prairie in Saskatchewan (Michener and Michener 1977), in Alberta (Schmutz et al. 1979), and at the western limit of the species' range (this study) have been studied for 2, 3, or 4 continuous years between 1969 and 1978, and the densities of adults have ranged from about 1 per ha (Michener and Michener 1977) to 10 or more per ha (Dorrance 1974). If, as seems likely, a combination of dispersal, predation, and overwinter mortality potentially contribute to total losses and to differential losses among sexes, then in any given location in any year one factor may predominate without eliminating the others as important factors under other conditions. Disputes between the relative importance of predation and overwinter mortality currently revolve

around persuasive arguments rather than empirical evidence, and will only be resolved by studies in which every individual is traced, by telemetry, to distinguish entry underground from late-season mortality and to distinguish death underground from early emergence in spring followed by death or dispersal.

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Man's Influence on Potential Nesting Sites and Populations of Swallows in Canada

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The nesting of the seven species of swallows (Hirundinidae) occurring in Canada was examined using the nest records assembled in Canadian nest records schemes. All species have been influenced by the actions of modern man, and more have been favourably affected through increased availability of nest sites than have declined, despite adverse competition from exotics introduced by man. Changes in breeding range related to environmental changes caused by man have occurred and are still occurring.

On a examiné la nidification de sept espèces d'hirondelles (Hirundinidae) au Canada, utilisant des fiches rassemblées dans les fichiers de nidification des oiseaux canadiens. Les activités de l'homme depuis la colonisation européene ont influencé toutes les sept espèces, mais la plupart des espèces ont profité à cause de la disponibilité augmentée des sites de nidification. Les alterations de l'environnement causée par l'homme ont aussi influencé la distribution de quelques espèces d'hirondelles, et tout ça continue toujours.

Key Words: Hirundinidae, swallows, nesting sites, Canada, nest records, populations.

Seven species of swallows (Hirundinidae) are widespread in Canada and the United States, including two which also breed in Europe, Asia, and North Africa, and another which breeds also in South America. All are at least moderately gregarious, and several nest colonially. Nesting is restricted more to particular situations, sites, or substrates than to special habitats. This paper explores some of the effects of actions by man, particularly since white settlement, on availability of nesting sites for North American swallows, and speculates on their indirect effects on numbers of those birds.

Materials and Methods

I examined all records through 1974 of swallow nests in the five major Canadian nest records schemes (NRS) (see Acknowledgments). The few records (less than 20 per species) in the Newfoundland NRS were omitted. Each nest was categorized as in a natural site or one affected by man's actions; some were not certainly assignable to either category. Obvious duplication within a year was eliminated, but not that between years. Published summaries (e.g., Bent 1942; Graber et al. 1972) and authoritative works on each species (q.v.) were consulted. Those sources described the entire spectrum of nest sites reported on the nest record cards without suggesting that any important types had been missed, and consequently no exhaustive literature review was attempted.

The relative abundance of each species in different parts of its range in Canada was inferred from results of the co-operative Breeding Bird Survey (BBS) (Erskine 1978, and unpublished data). Those data are believed suitable for broad comparisons of relative density within a species, but not for comparisons between species.

Results

Data for each species are summarized below.

The species are arranged according to type and construction of nests, rather than in taxonomic order. The sequence followed starts with species that use existing cavities, first those that were originally (as far as we can infer) obligate tree-hole nesters, followed by more tolerant species that accept cliff crevices and bank burrows as well as tree holes. Last come species that actively prepare their own nests by excavating burrows or by building fully or partly enclosed structures from clay pellets.

PURPLE MARTIN (*Progne subis*)

Our largest swallow is the northernmost representative of a South American group. Its history of association with man extends back before white settlement, when martins already nested in gourds hung up for them by Amerindians (reviews by Allen and Nice 1952; Jackson and Tate 1974). Its use of natural nest sites is now seldom reported in the east; presumably those were in tree cavities, with no more than four or five nests in any tree, as was still the case recently in the west (Richmond 1953; Finlay 1975). Among roughly 3000 nests reported by Canadian nest records schemes, only seven were stated to be in trees or stubs, and five of those were from British Columbia's small coastal population, from which only one nest box record was also available.

Now most martins use artificial nest boxes, including multiple-unit "hotels" as well as single boxes.

Many Canadian nest records reported only the number of "hotels," which may have up to 30 or more compartments; in such cases the number of occupied nests could only be guessed at. Mean colony size, calculated from reported data, varied from five pairs in Ontario to nine in New Brunswick, ranging from isolated pairs up to clusters of hotels housing over 50 pairs. In Canada, martins are found mostly in towns and cities, and 24 old records from Ontario referred to nests within the walls or roofs of buildings.

TREE SWALLOW (*Iridoprocne bicolor*)

The arrival each year of this relatively boreal swallow represents "spring" to many Canadians. It nests singly in tree holes and nest boxes, often near human habitations. Its natural sites are relatively difficult to find and to inspect; only 14% of 4370 reported sites were in tree holes, largely of woodpecker origin (Table 1). Natural sites made up an appreciable fraction of the available records only in British Columbia (Table 1), where several thesis studies had concerned themselves with hole-nesting birds (Erskine 1960; McLaren 1963; Kelleher 1963). The vastly higher proportion of natural sites in British Columbia may also reflect the relatively higher density there of flickers (*Colaptes*) (cf., Erskine 1978, Tables 3–8), whose nest cavities are often used by Tree Swallows.

There were only two records, both by experienced observers, of Tree Swallows nesting in holes in earth or rock cliffs; cavities in the walls of buildings were seldom used by this species. Tree Swallows evidently find cliff sites unacceptable, and should be viewed as having been obligate tree-hole nesters originally, unlike the following species.

Most nest sites classified as affected by man's actions were nest boxes, usually erected for bluebirds (*Sialia* spp.), diving ducks (*Bucephala* spp.), or for Tree Swallows specifically. Cavities excavated by woodpeckers in poles or posts erected by man were also listed as affected by man.

VIOLET-GREEN SWALLOW (*Tachycineta thalassina*)

A species confined to western North America, this swallow either breeds as single pairs in tree cavities, openings within the walls or roofs of buildings, or in artificial nest boxes, or else in groups in rock crevices (Edson 1943). All of the 550 Canadian nest records were from British Columbia, and 42% were in natural sites, chiefly as colonies in cliffs. Nest boxes and the walls and eaves of buildings accounted for most of the other 58%.

Cliff-nesting might be expected to have been originally more prevalent in the sparsely vegetated interior areas of British Columbia, with tree cavities predominating in the coast forests. Unfortunately, I did not segregate the different types of nest sites used by geographic area within the province. We do not know whether birds reared in tree holes will accept holes in buildings (artificial cliffs) or only nest boxes (artificial tree holes), and conversely whether birds reared in cliff sites will or will not accept other sites.

ROUGH-WINGED SWALLOW (*Stelgidopteryx ruficollis*)

This brown-backed swallow breeds from South America to southern Canada, and most nest records examined were from southern Ontario and British Columbia. It nests in small groups and as isolated pairs in various bank and cliff situations, using burrows (some or all made by other species) (Lunk 1962) in earth banks, or existing openings in rock walls. Excluding unassignable records, 68% of the 725 nests reported were in natural sites and only 32% in burrows in gravel pits or road cuttings, or (especially in Ontario) holes in cement, brick, or stone walls (cf., Lewis 1944).

Whereas burrows by rivers predominated in British Columbia, man-made sites were most commonly used in Ontario, the most settled (by humans) and altered part of Canada (Table 2). Colony size was higher in British Columbia than elsewhere (Table 2), and the

TABLE 1—Regional variations in proportions of natural and man-made sites used by Tree Swallows in Canada

	% of recorded nests in				
	Natural sites	Man-affected sites			
Region	Woodpecker holes in trees and stubs	Woodpecker holes in poles and posts	Nest boxes	Other sites	Total nests
Maritime provinces	4	5	88	2	466
Quebec and Ontario	9	4	86	1	2113
Prairie provinces	4	1	93	2	1059
British Columbia	46	4	44	6	732
All regions	14	3	81	2	4370

TABLE 2—Regional variations in proportions of natural and man-made sites used by Rough-winged Swallows in Canada

Region	% of assignable nests		Total number (mean number/colony)		Uncategorized nests (% of gross)
	Natural sites	Man-made sites			
Maritime provinces	100	0	1	(1)	0
Quebec and Ontario	50	50	213	(2)	19
Prairie provinces	78	22	18	(2)	0
British Columbia	75	25	493	(15)	12
All regions	68	32	725	(4)	14

species is also relatively more common in that province, judged by BBS data.

BANK SWALLOW (*Riparia riparia*)

In Eurasia as well as North America, this small swallow nests colonially in burrows which it excavates in near-vertical banks of earth, clay, and fine gravel (Petersen 1955). Nearly one-third of the nest records could not be categorized as natural or affected by man. Of those assigned (27718 in all) about 40% were in natural sites, mainly along sea coasts, rivers, and lake shores where erosion by water or wind led to exposure of earth slopes. The remaining 60% were in cut banks created by man — sand and gravel pits, road and railway cuttings, and various excavations, except for about 1% in piles of gravel stored for road repairs (cf., Nero 1968), and a few in old sawdust heaps (cf., Greenlaw 1972).

The data for various regions of Canada are summarized in Table 3. Natural sites were more often reported where human densities are relatively lower, and particularly in the Maritimes where coastal cliffs are also frequent. Man-made sites made up a larger proportion of the records in Quebec and Ontario, where human population, and presumably also habitat disturbance, is greatest. Man-made situations are predominant in British Columbia, where most records reported nests in roadside cut banks. Munro's monograph (1945) on birds of the Cariboo Parklands, then an undeveloped area with rather primitive roads, omitted Bank Swallows, which now are regular there (Erskine and Stein 1964). Road-building may thus have permitted more general distribution of a formerly localized species.

Mean colony size was much lower in the prairies than elsewhere. The relative paucity of nest records as well as the relative density data from BBS suggest that Bank Swallows are scarcer there too.

CLIFF SWALLOW (*Petrochelidon pyrrhonota*)

Cliff Swallows build up their nests from clay pellets plastered against vertical or overhanging walls of cliffs or structures. The nests are fully enclosed, gourd-shaped structures, often assembled in large colonies (Mayhew 1958). Such nests depend on virtually complete overhead protection from rain and runoff water, whether on cliffs or buildings. Of 21096 Canadian nest records, only 23% were in natural sites on cliffs, the rest being on buildings, bridges, culverts, and dams.

Cliffs are presumed to be more prevalent in the western mountains than in most of the flatter regions farther east, and records of natural cliff nest sites were almost all from the west (Table 4), with colonies of 1000 or more nests along the Bow River near Calgary, Alberta. The latter biased the regional comparisons (Table 4) of natural vs. man-affected sites and of mean colony size, as no comparably large colonies were reported in British Columbia. The BBS density indices, however, were as high for those parts of British Columbia where the species was recorded as for Alberta.

TABLE 3—Regional variations in proportions of natural and man-made sites used by Bank Swallows in Canada

Region	% of assignable nests		Total number (mean number/colony)		Uncategorized nests (% of gross)
	Natural sites	Man-made sites			
Maritime provinces	75	25	8207	(56)	1
Quebec and Ontario	35	65	9934	(38)	39
Prairie provinces	57	43	509	(5)	0
British Columbia	13	87	8568	(59)	35
All regions	40	60	27218	(42)	29

TABLE 4—Regional variations in proportions of natural and man-made sites used by Cliff Swallows in Canada

Region	% of recorded nests in Natural sites	% of recorded nests in Man-made sites	Total number of nests (mean number/colony)	
Maritime provinces	trace*	100–	1305	(19)
Quebec and Ontario	trace*	100–	1702	(8)
Prairie provinces	57	43	6735	(102)
British Columbia†	9	91	11354	(31)
All regions	23	77	21096	(30)

*Trace = much less than 0.5%.
†Including a few from Yukon Territory and Northwest Territories.

BARN SWALLOW (*Hirundo rustica*)

This composition species is "the swallow" of English proverbs, as familiar in Eurasia as in North America. Barn Swallows build their bracket-shaped mud-pellet nests solitarily or in loose colonies inside barns and other open buildings and under the porches and eaves of occupied homes (Samuel 1971), although the original sites were presumably all on overhanging cliffs or in caves. Of the eight locations in Canada where natural sites were reported in use, all in the eastern provinces, four were in national parks and two in a provincial park. Possibly such parks are among the few areas frequented regularly by man where buildings are scarce or lacking. Among nearly 5000 nests recorded in Canada, only 48 (1%) were on cliffs or in caves, the rest being in (54%) or on the outside of buildings (33%), or on other structures (12%). Perhaps more than any of our other swallows, its range may be still changing rapidly in response to man's activities, as is discussed later.

Discussion

(*i*) *Biases.* The nest records reflect the sites that observers were able to find and inspect. Those are certainly biased towards man-altered habitats and man-associated nest sites (cf., Erskine 1971), so that nests located by roadsides, around houses and settlements, and in agricultural areas are certainly reported in larger proportions than the natural sites in undeveloped, and unvisited, areas. When the vast majority (over 99%) of sites reported are man-influenced, however, as for Purple Martins and Barn Swallows, this is likely to reflect the real situation.

(*ii*) *Effects of man* on natural nest sites of swallows. Man's impact on natural nest sites probably affected tree-hole nesters most. At the time of European settlement, eastern Canada south of the tundra was almost entirely forested. Subsequently, southern Ontario and the St. Lawrence lowlands of Quebec, as well as parts of the Maritime Provinces, were largely cleared for settlement and agriculture (cf., Edwards 1969). Similar clearing of formerly forested land took place all along the northern edge of the prairies, and in the lower Fraser Valley of British Columbia. Everywhere, the large trees were the first to go. More recently, dead trees and snags are being eliminated, on the grounds of unsightliness in settled areas, and as foci of infection by forest insects or as fire hazards in cutover and regenerating forest lands. Thus, the large and dead trees in which woodpeckers most often make cavities — usable by swallows — have been reduced much more than the present extent of forest lands might suggest. Man has probably had little overall influence on availability of other types of natural nest sites used by swallows.

(*iii*) *Trends in use of new nest sites* resulting from man's activities. Despite man's effect in reducing availability of natural sites for some swallows, man-made situations undoubtedly have provided many additional nesting opportunities. Purple Martins are perhaps the most "domestic" of swallows now, as most of the sites they use are deliberately provided for them by man, in close proximity to human dwellings. This association began before white settlement, and adaptation to artificial sites may have been gradual. Although martins often assemble in far larger colonies in man-made boxes than can have existed in natural tree sites, the size of colonies still averages only 5.8 nests (calculated from data in Jackson and Tate 1974).

Tree Swallows were originally no less obligate as tree-hole nesters than martins, but their dependence on man-made sites is much less. Possibly their association with man is of more recent origin, since their more northern distribution would have brought them in contact, before white settlement, mainly with Amerindians of nomadic habits, whereas the early "adoption" of martins was by sedentary agricultural tribes (Allen and Nice 1952).

The importance of nest boxes to Tree Swallows can easily be overestimated. I suggest, largely on the basis of "bluebird trail" reports, that nest boxes systemati-

cally erected for bluebirds and other birds may accommodate perhaps 10000 pairs of Tree Swallows annually across Canada, and backyard nest boxes may add another 10000 pairs, say 20000 pairs in all. This looks impressive, but I have also estimated, from density data given by Graber and Graber (1963) and Stewart and Kantrud (1972) and the BBS density indices (Erskine 1978, Tables 3–8), that the total Canadian population of Tree Swallows may be roughly one million pairs. Neither of these estimates is precise, but they should serve to provide the necessary perspective. The increase effected by use of nest boxes is apparently in the order of 2%, which is almost certainly insufficient to counterbalance the losses of natural tree nest sites throughout the settled parts of Canada in the last 200 yr.

The apparent ability of Violet-green Swallows to use both tree and cliff sites deserves study. That species is tolerant of a wide spectrum of nesting cavities, which presumably has eased its acceptance of man-made sites. Its domesticity in using backyard nest boxes and holes in the eaves of houses is in marked contrast to its nesting in remote cliffs. Rough-winged Swallows, which also use crevices in rock cliffs, are possibly the least domestic of all Canadian swallows; they have made no real adaptation in using existing cavities in man-made as well as natural banks and cliffs. It seems likely that man has not had much influence on nesting by those two species.

Bank Swallows excavate their burrows in man-made banks exactly as they do in natural situations. The much greater availability of cut banks and excavations, even in flat areas, undoubtedly allows more general distribution of that species than in former times.

Nesting sites for Cliff Swallows have become far more generally available as a result of man's actions. That species is much more widespread and abundant in the west than in eastern North America (Erskine 1978, Tables 3–8), as was also the case in the early 1800s (Bent 1942). In contrast, Barn Swallows have an eastern predominance today (Erskine 1978), but natural sites cannot originally have been numerous in eastern North America, as is also suggested by the present scarcity of the species in areas without human settlement. The readiness of Barn Swallows to build nests on newly-constructed buildings suggests that they may have colonized permanent dwellings as soon as these were built by European settlers in America.

Barn Swallows have recently spread southwards in the southeastern United States, as shown by comparison of recent BBS data with the range given in the AOU Checklist (1957) only 15 yr earlier (D. Bystrak, United States Fish and Wildlife Service, unpublished data; Reid 1975). Prior to 1964, the Barn Swallow also had not been recorded in northern Alberta, an area with no cliffs and few settlements (Erskine 1968), but with opening of that area for agriculture and oil prospecting it is now seen regularly. Samuel (1971) thought there was little competition between Barn and Cliff Swallows in West Virginia, although they frequently occurred together.

(*iv*) *Effects on swallows of competition by introduced exotics.* The introduction to America by European settlers of the House Sparrow (*Passer domesticus*) and Starling (*Sturnus vulgaris*) has had adverse effects on most native hole-nesters with which the newcomers compete for nest sites. In the southern states, where Purple Martins are relatively more common and Starlings and sparrows less common than farther north, Jackson and Tate (1974) considered such competition a minor influence on martin numbers. But farther north, near the limits of their range, some martin colonies have been abandoned as a result of competition with sparrows and Starlings when no efforts were made by man to protect them (e.g., Brinkman, *in* Graber et al. 1972). In the west (Oregon and Alberta), Purple Martins did not accept nest boxes until after the introduced competitors had arrived. House Sparrows were extremely local on the west coast until 1900–1910 (Robbins 1973), and Starlings did not breed in British Columbia until about 1948 (Myres 1958).

One or other of the Tree or Violet-green Swallow was the most common bird species in three northern frontier towns in which both House Sparrows and Starlings were present (Erskine 1977, Table 12), but census data show that in southern Canadian cities House Sparrows and Starlings are much more common than any swallow species (Speirs et al. 1970; Weber 1972). Detailed studies of competition are lacking, but competition with the introduced pests has presumably influenced both Violet-green and Tree Swallows, especially in urban areas.

Bent (1942) quoted a few records of House Sparrows and Starlings using Bank Swallow burrows, and this is evidently rare in Canada too. Competition from House Sparrows adversely affects Cliff Swallows nesting on farm buildings (Samuel 1969), but probably has less influence on those nesting in other situations. It seems likely that the rapid initial spread in range and increase in numbers of Cliff Swallows in the east, following their acceptance of buildings as nesting situations in the early 1800s (Bent 1942), was reversed less than a century later by the influence of House Sparrows. Barn Swallows are very seldom bothered by House Sparrows, which prefer a fully enclosed nest site.

(*v*) *Effects on swallows of possible changes in insect populations.* In the Maritime Provinces and probably

also in eastern Ontario, I have the impression that Tree Swallows have become markedly scarcer over the past 25 yr, and especially between 1950 and 1960, both absolutely and relative to Bank and Barn Swallows (cf., my comments *in* Boyer 1966). The low numbers I found in the Maritimes in 1960 could have reflected losses in 1958 and 1959, but that leaves unexplained their failure to recover subsequently, and their similar scarcity in eastern Ontario after I moved there in 1968. Competition with House Sparrows and Starlings is unlikely to be implicated, as both exotics were well established in those areas before 1950. I believe the decrease more likely to reflect a reduction in flying (and biting) insects in and around urban areas as a result of the widespread use of DDT and other insecticides for forest spraying and mosquito control. Such insects were still conspicuously present in the frontier towns (with abundant swallows) that I censused in 1970–1975, although I have no quantitative data on insects. Increased use of cars, with resultant increase in air pollution, is also well correlated in time and space with the apparent recent decline of Tree Swallows in urban areas.

The continued relative success of Purple Martins in urban areas may reflect their tendency to forage higher above the ground than other swallows. Local insecticide spraying and air pollution in cities and towns may have less effect in reducing the high-flying insects on which martins feed.

(*vi*) *Conclusions.* Historical records generally provided little information other than presence in an area as opposed to absence from it, which is of use in assessing changes in distribution, but little help in detecting trends in numbers. The changes in numbers which I am suggesting in Table 5 are based on my experience in using nest records and in interpreting population data, and on my personal impressions from 25 yr of field work across Canada. My suggestions are certainly speculative, and some people will question my summation of the various influences acting on swallows.

The order in which the species were discussed reflected their success in coping with man's effects on their environment as well as the types of nests they used. The obligate tree-hole nesters, discussed first, depended on trees large enough to accommodate cavities. Those birds seem to have come off least well, losing potential nest sites with the cutting of trees for settlement and agriculture as well as for timber, and suffering from competition by introduced hole-nesting species. The more tolerant cavity-nesting swallows have been able to cope better with man-caused changes, but have neither decreased nor increased. Finally, the species that actively construct their own nests have been able to take advantage of either man's penchant for excavation or his buildings, and those species all have prospered. None of our swallows, however, can be considered extreme examples of response to man's actions; none has been reduced to threatened status or extirpated, either through direct persecution or damage to its environment; and none has burgeoned to the point of becoming a pest. Few other families of passerine birds have become as closely associated with man without achieving either domestic or pest status.

I believe it desirable to show that not all species of birds are necessarily affected adversely by changes brought on by man. Even highly migratory and esthetically pleasing species, including several of the swallows, have become almost totally dependent on man for nest sites. We should be aware of the extent of such dependence when we make environmental decisions.

TABLE 5—Man's effects on swallow numbers in Canada, judged from nest-site selection and availability. Key to impacts: — major decrease; – moderate decrease; o little or no change; + moderate increase; ++ major increase

Species	Impact of man's actions on swallows			Suggested changes from original status
	Availability of natural sites	Competitors introduced*	Availability of new sites	
Purple Martin	—	—	++	–
Tree Swallow	—	–	+	–
Violet-green Swallow	o; –†	–	++; +	o
Rough-winged Swallow	o	o	+	o
Bank Swallow	o	o	++	+
Cliff Swallow	o	–	++	+
Barn Swallow	o	o	++	++

*House Sparrow, Starling.
†Cliffs and trees listed separately, also buildings and nest boxes.

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Distribution and Habitats of Four Annual Smartweeds in Ontario

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Polygonum lapathifolium, P. pensylvanicum, P. persicaria, and *P. scabrum* are closely related and morphologically similar smartweeds. They often occur together on riverbanks in southern Ontario; outside of riverbanks, their habitats and distributions differ. *Polygonum lapathifolium* is found on damp disturbed substrates throughout the province (variety *lapathifolium* predominates in the south, and variety *salicifolium* in the north); *P. pensylvanicum* is found (as varieties *pensylvanicum* and *laevigatum*) on well drained soils of lakeshores, riverbanks, and occasionally in farmland in southern Ontario. *Polygonum persicaria* and *P. scabrum* have been introduced from Eurasia; in Ontario their distributions are more or less restricted to wasteland, and cultivated regions where they are locally common as weeds in cereal crops. A key and line drawings are provided for identification purposes.

Annual smartweeds or persicarias (Genus *Polygonum*, Section *Persicaria*) are a group of similar species which inhabit croplands, as well as wet and disturbed sites in many parts of the world. In Ontario, several species are widespread and occur with high population densities in many locations. The similarity between species has resulted in their frequent misidentification, or in their being lumped together as "smartweeds." Furthermore, two or more species may be found together in close proximity, and this raises the question of how very similar species can occur together without one succeeding at the expense of the others. One possible answer to this question is that each is predominant in at least one kind of habitat.

The purpose of this study was to clarify and compare the distribution and habitats of four species and their varieties in Ontario. The species studied were Pale Smartweed (*Polygonum lapathifolium* L.), Pennsylvania Smartweed (*P. pensylvanicum* L.), Lady's-thumb (*P. persicaria* L.), and Green Smartweed (*P. scabrum* Moench). We follow the nomenclature and classification of Scoggan (1978) by recognizing four species and a number of varieties. A similar classification has been used by Fernald (1950); however, others (e.g., Gleason and Cronquist 1963) have preferred to treat *P. scabrum* Moench as a variety of *P. lapathifolium* (*P. lapathifolium* variety *incanum* (Roth) K. Koch). By referring to herbarium records, we have documented the distribution of these smartweeds in Ontario. We have also documented, after an intensive survey, their habitats in Middlesex County, Ontario.

Methods

Specimens from Ontario were examined from the following herbaria during 1972 and 1973: OAC, UWO, TRT, CAN, DAO, SLU, HAM, WLU, WAT, QK, LKHD, MT, MTJB, MTMG, MICH, MSC, and the University of Windsor. Morphological data recorded from these herbarium specimens was later (1978) used to check specimen identification against keys in the recently published *Flora of Canada* (Scoggan 1978). Each specimen was identified to variety where possible and its geographical location was then plotted.

A study area (approximately 3500 ha) was selected near the village of Delaware, Middlesex County, Ontario (42°55′N, 81°25′W). A significant criterion in the selection of this area was that it possessed a variety of habitats and soil types (Anonymous 1931). The habitats included cropland (cereals, corn, tobacco, hay, beans, vegetables), pasture, deciduous woodland, roadsides, and river bottomlands. Soil types included "sands" (Berrien and Fox-fine sandy loams, Oshtemo and Plainfield sands), "loams" (Guelph, London, and Parkhill loams and Burford gravelly loam), and "clays" (Haldimand, Huron, and Perth clay loams). Sands, loams and clays, as defined above, occupied approximately equal proportions of the study area. The Thames River flows southwards through the center of the area. Many tributaries enter this portion of the river via gulleys on its east and west banks.

A survey of the study area was designed to examine the distribution of the smartweeds in different

habitats and on different soil types. The study area was subdivided into three edaphic types: sand, loam, and clay; 300 sampling units (each circular with diameter of 3 m) were placed randomly in each soil type in such a way that 100 were in cropland, 100 in woodland, and 100 in disturbed sites other than cropland (e.g., roadside verges). The presence or absence of each smartweed species was recorded in each of the 900 sampling units. If the sampling unit fell in the wrong habitat, it was moved to the nearest example of the appropriate habitat. A field check of the soil type was made at the time that a plot was placed in the field. In each sampling unit the soil type was the same as that shown on the Department of Agriculture soil map (Anonymous 1931).

The frequency of each smartweed species was determined from 300 sampling units placed along both sides of a 6.5-km section of the Thames River, near London, within the study area. Each bank was divided into 50 sections each 130 × 10 m. Three circular sampling units, each 1 m in diameter, were placed at random within each section. This habitat was treated separately from those of the previous survey because riverbank soils could not be classified as sand, loam, or clay and because the sampling procedure differed.

Results and Discussion

Distribution in Ontario

Table 1 gives the numbers of herbarium specimens examined; most of these were identified to variety level. Three varieties (*P. lapathifolium* variety *prostratum* Wimm., *P. pensylvanicum* variety *durum* Stanford, *P. persicaria* variety *ruderale* (Salisb.) Meisn.) are not recorded by Scoggan (1978) for Ontario and this is probably the first report of these taxa for the province. A key (Table 2) and line drawings (Figure 1) are provided for the identification of Ontario taxa. The key has been modified from keys in Scoggan (1978) to include only those taxa (to variety level) found in Ontario, and expanded to include the previously unreported *P. pensylvanicum* variety *durum* and a key to allow the separation of *P. persicaria* variety *persicaria* from *P. persicaria* variety *ruderale* (Salisb.) Meisn.

Polygonum lapathifolium was the most widespread species (Figure 2). The most northerly specimen (CAN 244332) was from Big Trout Lake (53°49′N, 89°53′W). *Polygonum lapathifolium* has been collected from all bedrock types, soil types (except tundra soils), vegetation zones (except tundra), land use types, and climatic regions of the province. Variety *lapathifolium* appears to be the commonest variety in southern Ontario. Specimens have been collected from riverbanks, damp agricultural land, roadsides, ditches, and wasteland. Variety *salicifolium* Sibth. is locally distributed in the south, but is the commonest variety in the northern part of the province. Specimens of this variety have been collected from sandy beaches of lakes and rivers, and

TABLE 1—The varieties of four annual smartweed species found in Ontario, based on herbarium specimens examined by the authors

Species	Variety	No. of specimens examined
Polygonum lapathifolium L.	*lapathifolium*	218
	salicifolium Sibth.	106
	prostratum Wimm.	1
		325
Polygonum pensylvanicum L.	*pensylvanicum*	81
	laevigatum Fern.	46
	durum Stanford[1]	2
	eglandulosum Myers[2]	0
		129
Polygonum persicaria L.	*persicaria*	349
	ruderale (Salisb). Meisn.	1
		350
Polygonum scabrum Moench		59

[1]Specimens appeared to be hybrids between variety *durum* and variety *pensylvanicum*.
[2]Not encountered in the specimens examined, but reported by Scoggan (1978) for islands in Lake Erie.

TABLE 2—Key to *Polygonum lapathifolium, P. pensylvanicum, P. persicaria,* and *P. scabrum,* and their Ontario varieties.[1] This key has been adapted from Scoggan (1978)

1 Ocreae (leaf-sheaths) normally fringed with bristles at summit. Spikes at least 7 mm thick; mature calyx prominently reticulate at base; achenes prevailingly lenticular; leaves often purplish blotched above; plants mostly of weedy habitats; (introduced) ..... *P. persicaria* L.

2 Stem ascending or merely decumbent-based; the leaves narrowly to broadly lanceolate; the spike to over 4 cm long ..... var. *persicaria*

2 Stem prostrate or depressed; the relatively short leaves rhombiclanceolate; the spike usually less than 1.5 cm long ..... var. *ruderale* (Salisb.) Meisn.

1 Ocreae nearly or quite lacking apical bristles; styles usually 2 (sometimes 3); achenes usually lenticular (sometimes trigonous)

3 Peduncles and axis of inflorescence with obvious stalked glands or strigose-hispid; spikes pink to purplish (rarely white); outer sepals obscurely nerved ..... *P. pensylvanicum* L.

4 Peduncles strigose-hispid, without or with very few glands ..... var. *durum* Stanford[2]

4 Peduncles and axis of inflorescence covered with gland-tipped hairs.

5 Leaves distinctly strigose on both surfaces ..... var. *pensylvanicum*[2]

5 Leaves glabrous or at most sparsely strigose on the midrib beneath .... var. *laevigatum* Fern.[2]

3 Peduncles and axis of inflorescence glabrous or with sessile inconspicuous glands; outer 3 sepals in fruit strongly 3-nerved, each nerve terminating in an anchor-shaped fork (except in *P. pensylvanicum* var. *eglandulosum*).

6 Spikes green (rarely purplish), to 5 cm long, erect, the lateral ones mostly sessile or short stalked; floral-axis copiously glandular; achenes about 3 mm long and about equalling the mature calyx; this not constricted at the tip; (introduced) ..... *P. scabrum* Moench[2]

6 Spikes pink to purplish.

7 Plant glabrous throughout; calyx pale, about equalling the somewhat shining achene, this is 3–5 mm long; spike erect, to 1–5 cm thick ..... *P. pensylvanicum* var. *eglandulosum* Myers

7 Plant often bearing sessile glands on the peduncles and lower leaf surfaces; calyx pink to purplish, constricted above into a thick beak overtopping the achene, this is not much over 2 mm long; spike often somewhat pendulous, not over 1 cm thick ..... *P. lapathifolium* L.

8 Leaves lanceolate, broadest near the base, attenuate to tip.

9 Leaves green on both sides, to 2–5 cm long; spikes to 8 cm long, arching or drooping ..... var. *lapathifolium*[2]

9 Leaves white-pubescent beneath, at most about 1 cm long; spikes less than 4 cm long; erect ..... var. *salicifolium* Sibth.[2]

8 Leaves broadest well above the base, not long attenuate.

Plant prostrate or depressed; leaves subrhombic, mostly not over 7 cm long; spikes to about 4 cm long ..... var. *prostratum* Wimm.

[1]Other annual smartweeds occur in Ontario (e.g., *P. caespitosum, P. careyi, P. hydropiper, P. orientale, P. punctatum*). These species are either rare, or more or less restricted to swampy ground (see Scoggan (1978) for treatment of these taxa).
[2]Specimens of this variety or species which possessed some characteristics of a second variety or species have been seen by the authors (see text).

from exposed muds. Many intermediates between these two varieties were noted; for the purposes of mapping, these were assigned to the variety which they most closely resembled. A specimen of the variety *prostratum* Wimm. (prostrate plant with broad leaves) had been collected from the vicinity of Waterloo (WLU 2689).

Polygonum pensylvanicum has the most restricted distribution of the four species studied (Figure 2). The most northerly specimen (WAT 718a) was from Sudbury (45°30′N, 81°00′W). The Ontario distribution is patchy with three main centers of density: (*a*) south of a line from Goderich to Toronto, (*b*) east of a line from Kingston to Renfrew, and (*c*) the Georgian Bay shoreline. Isolated colonies occur at Nestorville (46°18′N, 83°36′W; MICH 5165), North Bay (46°19′N, 79°28′W; TRT 16735), and Sudbury (46°30′N, 81°00′W; WAT 718a). Variety *pensyl-*

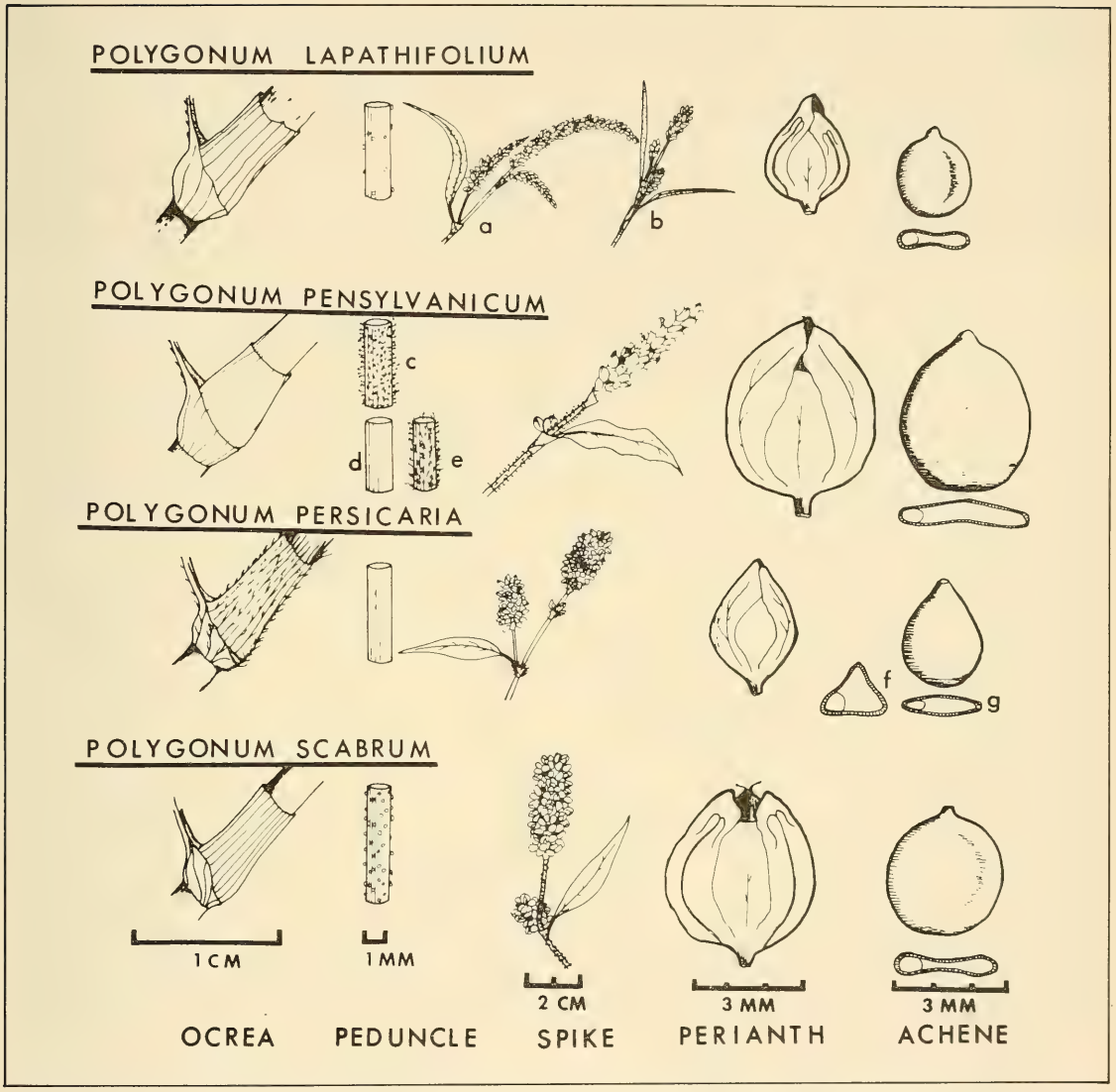

FIGURE 1. Ocreae, peduncles, spikes, perianths, and achenes (surface and cross sectional views) of annual smartweeds showing major distinguishing features used in the key (Table 2). Spikes of (a) *P. lapathifolium* variety *lapathifolium*, and (b) *P. lapathifolium* variety *salicifolium*. Peduncles of (c) *P. pensylvanicum*, varieties *laevigatum* and *pensylvanicum*, (d) *P. pensylvanicum* variety *eglandulosum*, and (e) *P. pensylvanicum* variety hybrid *durum* × *pensylvanicum*. Cross sections of (f) trigonous and (g) lenticular achenes of *P. persicaria*.

vanicum and variety *laevigatum* Fern. are both common and have similar distributions; however, their main centers of density differ. Variety *pensylvanicum* predominates on the Niagara peninsula, but variety *laevigatum* is the most frequent variety in the vicinity of Ottawa and in Elgin and Middlesex counties. Many intermediates between these varieties were noted and, for mapping purposes, were assigned to the variety which they most closely resembled. Two specimens were identified by the authors as intermediates between variety *durum* Stanford and variety *pensylvanicum*. These had been collected from Point Edward, Lambton County (DAO 1862) and Birch Island, Lake Huron (CAN 44437). No mention is made of the occurrence of variety *durum* in Ontario by Scoggan (1978); however, Gleason (1958) reports a

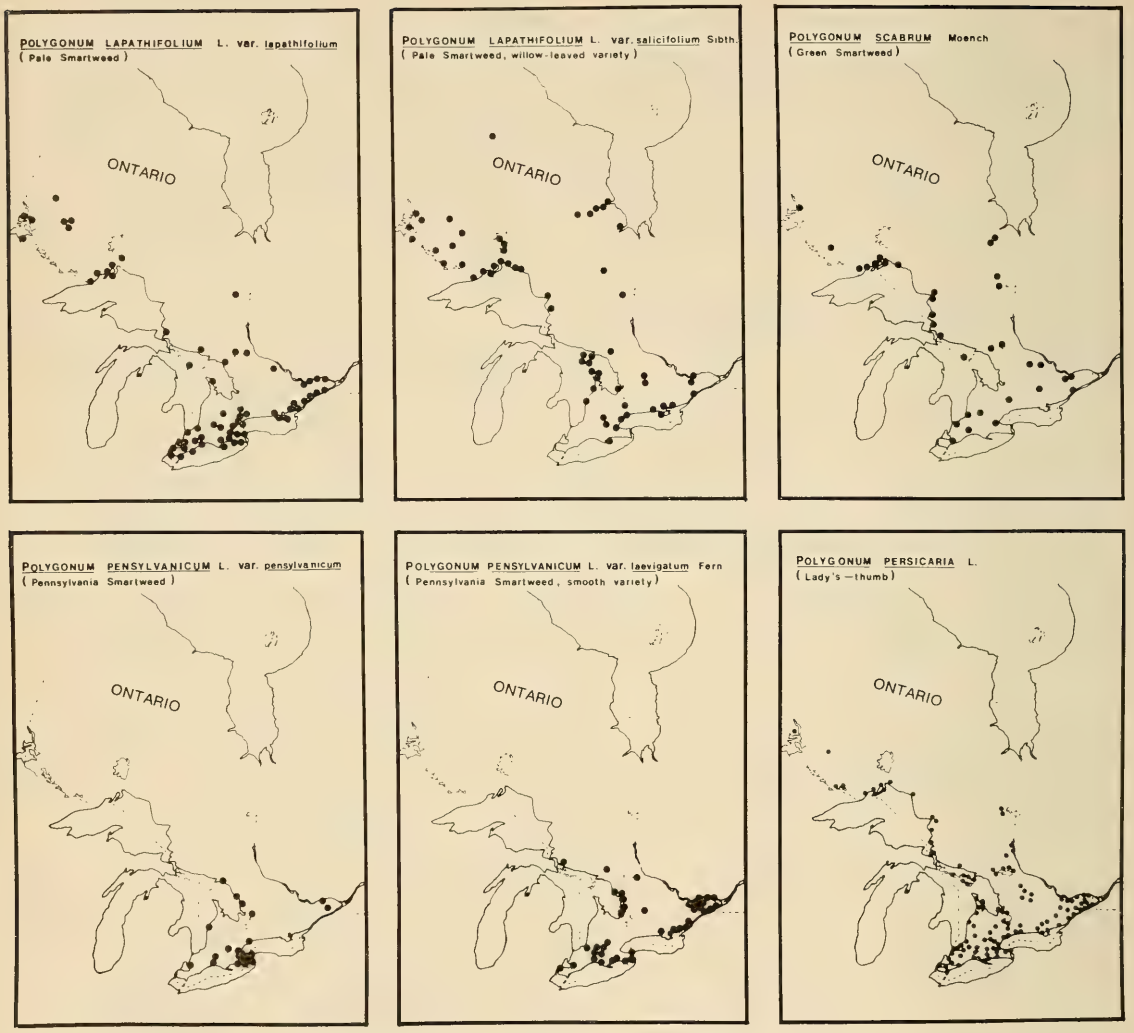

FIGURE 2. Distribution of four annual smartweeds and their common varieties in Ontario, based on examination of herbarium specimens.

similar variety intermediate from Indiana. Specimens of *P. pensylvanicum* have been collected from riverbanks, lakeshores, and croplands.

The distribution of *P. persicaria* was most concentrated in the southern half of the province although specimens have been collected from the clay plains of Kenora, Dryden, Thunder Bay, Kapuskasing, and New Liskeard. The most northerly specimen was from Sioux Lookout (50°06′N, 91°55′W). Most habitats given on specimen sheets were described as cultivated land or disturbed sites. The species was recorded from all soil types including Precambrian deposits. A single specimen of *P. persicaria* variety *ruderale* (Salisb.) Meisn. was identified by the authors. This specimen (WAT 39) had been collected from Conestogo Lake, Waterloo County.

Polygonum scabrum had not been separated from *P. lapathifolium* in certain of the herbaria visited. Data pertaining to peduncle, spike, perianth, and achene characteristics were used by the authors to discriminate between these two species using the key provided by Scoggan (1978). Many specimens possessed characteristics of both *P. scabrum* and of *P. lapathifolium* (either variety *salicifolium* or variety *lapathifolium*). Such specimens were assigned to the taxon which they most closely resembled. *Polygonum scabrum* is of widespread but local occurrence in Ontario; it is particularly abundant in the vicinity of

Thunder Bay. The most northerly specimen (TRT 107340) had been collected from Onakawana on the Moose River. Information on herbarium sheet labels showed that specimens had been collected from clay or loam soils of farmland and roadsides, and a few from riverbanks.

Soil and Habitat Survey

Percentage frequencies for *P. lapathifolium* and *P. persicaria* in each of the nine habitat-soil categories are shown in Table 3. *Polygonum pensylvanicum* and *P. scabrum* were not encountered in this survey, and with the exception of one plant of *P. persicaria*, no smartweeds were found in woodland.

TABLE 3—Frequency and total number of two smartweeds in three habitats and on three soil types in Middlesex County, Ontario. Number of sampling units in each soil type in each habitat = 100

Species, habitat	Frequency (%)			Total number
	Sand	Loam	Clay	
P. lapathifolium				
Cropland	1	0	0	1
Disturbed sites	4	2	0	6
Woodland	0	0	0	0
Total number	5	2	0	7
P. persicaria				
Cropland	9	24	28	61[d]
Disturbed sites	25	24	24	73[d]
Woodland	1	0	0	1[a]
Total number	35[b]	48[b,c]	52[c]	135

[a–d]Row or column totals associated with the same letter are not significantly different from each other ($P > 0.05$).

Polygonum lapathifolium was scarce (encountered in only 7 of 900 sampling units); most occurrences were in disturbed sites. Frequency values were too low for statistical comparison. All specimens were of variety *lapathifolium*.

Polygonum persicaria was common in croplands and in disturbed sites on sandy, clay, and loam soils. The frequency values were sufficiently large to allow statistical testing of four null hypotheses:

i) That the frequency of *P. persicaria* on different soils was independent of its frequency in different habitats was rejected ($P < 0.05$) using the G-test (Sokal and Rohlf 1969). *Polygonum persicaria* was most frequent in croplands where these were situated on clay soils.

ii) That the frequency of *P. persicaria* did not differ between soil types, or between cropland and disturbed sites was tested by means of pairwise comparisons using the simultaneous testing procedure (Sokal and Rohlf 1969). The frequency on clay soils was significantly higher ($P < 0.05$) than that on sandy soils. Frequency values for other pairs of soil types, and between habitats, cropland, and disturbed sites were not significantly different.

iii) That the proportion of occurrences of *P. persicaria* in cropland increases as one progresses from sandy through loam to clay soils (i.e., with decreasing particle size) was accepted ($P > 0.05$) after testing of linear proportions (Snedecor and Cochran 1967).

iv) That *P. persicaria* occurs with equal frequency in different crop types was tested using an R × C test of independence based on the G-statistic, and by pairwise comparisons using the simultaneous testing procedure (Sokal and Rohlf 1969). These tests took into account the total numbers of sampling units in each crop type, in such a way that the scarcity or abundance of sampling units in a particular crop species did not affect the results of the test or provide misleading information. The frequency of *P. persicaria* in small-grained cereals was shown to differ ($P < 0.05$) from that in other crops (Table 4). Small-grain cereals are usually grown on clay or loam soils in the study area. From these studies it is not possible to separate the effects of clay and loam soils from the effects of small-grained cereals on the frequency of *P. persicaria*. A further complicating factor is that the principal crops on drier soils (corn and tobacco) are usually heavily sprayed with herbicides (such as Atrazine), to which smartweeds are susceptible.

TABLE 4—Frequency of *Polygonum persicaria* in various crop types

Crop type	Corn	Small-grained cereals[1]	Other crops[2]
Number of sites examined	146	85	69
Number of occurrences of *P. persicaria*	7[a]	54[b]	2[a]

[a–b]Frequencies associated with the same letter are not significantly different from each other ($P > 0.05$).
[1]Wheat, barley, oats, rye.
[2]Tomato, tobacco, beans, melon.

Riverbank Survey

Polygonum lapathifolium variety *lapathifolium*, *P. pensylvanicum* variety *laevigatum*, and *P. persicaria* were encountered in the riverbank survey (Table 5). The null hypothesis that their frequency values did not differ was tested by means of a G-test and by simultaneous testing procedure (Sokal and Rohlf 1969). The null hypothesis was rejected ($P < 0.05$)

TABLE 5—Frequencies of smartweed species along banks of the Thames River, Middlesex County, Ontario

Species	Frequency (%)[1]
Polygonum lapathifolium	49
Polygonum pensylvanicum	22
Polygonum persicaria	10
Poilygonum scabrum	0

[1]Each value is significantly different from each other value ($P < 0.05$).

indicating that the values were different from each other. It is of interest that *P. persicaria*, the commonest species in cropland and disturbed sites (habitat and soil survey), was the rarest of the three riverbank species. *Polygonum pensylvanicum,* which was absent from the previous survey, was common on riverbanks. *Polygonum scabrum* was absent from riverbank sites, as it was from the habitats examined in the previous survey.

Summary

The distributions and habitats of the four smartweeds based on our herbarium studies and field surveys, are summarized in Table 6.

Polygonum lapathifolium has long been associated with man's agricultural activities (Bertsch 1954) and with man's assistance has increased its range to most temperate parts of the world. It is probably not sufficiently abundant in the croplands of southern Ontario to be rated as a serious weed in that region. It is more usually found in wet and naturally disturbed sites, such as riverbanks, lakeshores, and exposed mud. It may be abundant in these habitats even at locations well away from farmland, e.g., in northern Ontario. When found as a weed, it is usually associated with damp, disturbed substrates, i.e., conditions very similar to those of the riverbank. Of the two common Ontario varieties, variety *salicifolium* is considered to be native but variety *lapathifolium* is believed to be partly introduced (Scoggan 1978). It is not known, however, whether the introduced element of this variety is the weedy component.

The range of the native species *Polygonum pensylvanicum* is more or less restricted to eastern North America, extending northwards to the Sudbury district of Ontario (for map, see Staniforth 1975). It is a serious agricultural weed throughout its range in the United States, but in Canada it is mostly restricted to riverbanks and lakeshores. When found as a weed in Ontario (locally in Kent, Essex, and Elgin counties), it is associated with crops grown on sandy soils (especially corn and tobacco). One may speculate that its northern distribution is correlated with locations offering a mild climate and light warm soils, such as those of riverbanks, beaches, and sandy farmland. Varieties *laevigatum* and *pensylvanicum* are both common in the province.

Polygonum persicaria, like *P. lapathifolium,* has long been associated with man's agricultural activities. It has become successfully established in North America from Eurasia. In Ontario, it is more restricted to agricultural and man-disturbed habitats than are the two species discussed above. It does occur in isolated farming regions such as the clay belt and the small farmed clay pockets of northern Ontario. *Polygonum persicaria* is associated particularly with damp, clay soils in Ontario, especially those which support crops of small-grained cereals, e.g., oats, barley, rye, and wheat.

Polygonum scabrum was originally introduced from Eurasia. It has become widely distributed in Canada and is now found in all provinces and in the Northwest Territories (Scoggan 1978). In Ontario, it is widespread and locally common on damp clay and loam soils of disturbed substrates, including cropland.

TABLE 6—Summary of the distributions and habitats of four annual smartweeds in Ontario

Species	Distribution, relative abundance	Principal soil type	Principal habitats
Polygonum lapathifolium	Throughout Ontario; common	Damp clays and loams	Riverbanks, lakeshores, sometimes farmland and waste places
Polygonum pensylvanicum	Southern Ontario; locally common	Well-drained loams, sands, and gravels	Riverbanks, lakeshores, locally in crops
Polygonum persicaria	All cultivated parts of the province; common	Damp clays and loams	Wasteland, cultivated land (cereal crops), occasionally riverbanks
Polygonum scabrum	Throughout Ontario; local	Damp clays and loams	Wasteland, cultivated land, occasionally riverbanks

It was not encountered during habitat surveys in Middlesex County, Ontario.

Acknowledgments

We thank the Canadian Northern Sportsmen's Show for financial support of this project. Comments offered by the referees were appreciated. The assistance and co-operation of curators of herbaria in Ontario, Quebec, and Michigan are also gratefully acknowledged. In addition, we thank H. Scoggan for permission to use his keys to species and varieties of *Polygonum*.

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Apparent Differences in Aquatic Macrophyte Floras of Eight Lakes in Muskoka District, Ontario from 1953 to 1977

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Miller, G. E. and H. M. Dale. 1979. Apparent differences in aquatic macrophyte floras of eight lakes in Muskoka District, Ontario from 1953 to 1977. Canadian Field-Naturalist 93(4): 386–390.

Forty-eight species of aquatic macrophytes were recorded in two surveys made 23 yr apart of the same areas in eight Muskoka, Ontario lakes. Only 69% of 265 sightings were duplicates in the surveys. Improved sampling methods resulted in additional records of deep-water species whereas certain floating-leafed species were no longer extant in some lakes. Some currently obvious species are thought to have changed sufficiently in abundance to produce the new records. In the shallow-water records, the changes in several subterranean and inconspicuous species were attributed to presence or absence of obvious flowers.

Key Words: aquatic plants, macrophyte, flora, biological surveys, freshwater lakes, long-term changes, Muskoka District, Ontario.

The process of eutrophication brings about changes in the aquatic flora in a short time (Lind and Cottam 1969; Harman and Doane 1970). Undisturbed aquatic stands, rephotographed in Scotland by Spence (1964) to compare with earlier photographs by West (1905) showed no significant successional change in aquatic communities after more than 50 yr. Dramatic changes more frequently result from man's activities, because they may alter the water chemistry, clarity, and temperature; these factors have been linked with species change (Dale and Miller 1978; Stuckey 1971; Volker and Smith 1965).

The scarcity of accurate floristic surveys of lakes hinders the weighing of the reality of an apparent change in a flora. Too often published records are based on traditional techniques using remote sampling from the water surface, with a rake or a grappling hook (Shields[1]; Soper[2]; Stuckey 1971), or an Ekman dredge (Rich et al. 1971). Direct examination of aquatic vegetation (in a manner comparable to those in which observations are made in terrestrial ecology) using SCUBA was introduced by Schmid (1965) and was the method used for this study.

The eight lakes studied are of the unbuffered, slightly acid type, characteristic of the Precambrian Shield of central Ontario. Three Mile Lake has an alkalinity of 9 mg $CaCO_3$/L and an electrical conductivity of 56 μmho/cm. The other seven lakes have alkalinities below 5 mg $CaCO_3$/L and conductivities in the range of 29–41 μmho/cm. All pH readings were in the range 6.0–6.6. Three Mile Lake has a noticeably larger clay component in its substrate; reduced water clarity resulted in a 2.1-m Secchi disc reading compared with the 3.9–9.4 m in the other lakes. Lakes such as these characteristically have both a low productivity of aquatic macrophytes and a low standing crop when compared with lakes richer in dissolved solids. It is not known whether these values have changed between the two sampling dates. Differences in the recorded flora are assessed as attributable to sampling technique, to man's influence on the environment, or to successional trends in the vegetation.

Methods

Three two-day surveys (by motor boat) were made of each lake by a team of three in the summer of 1976. Several stands (10 to 20) were carefully surveyed using SCUBA or skin-diving equipment. Sampling sites were chosen so that areas fully described in the former survey on the maps of Shields[1] were revisited. In addition, sites of unique features as well as ones characteristic of the lake were included. The vegetation in an area 1000 m^2 was surveyed and all submersed and floating aquatic plant species were rated for abundance on the scale: 0, absent to 4, abundant. Each species was given a mean abundance rating for each lake using the same scale. This index indicated the frequency of an expected encounter. The herbarium at the University of Guelph (OAC) houses a sample of each species. Five of the eight lakes were revisited in 1977 to check typical locations for species apparently 'lost' since 1953.

[1]Shields, J.K. 1953. A survey of the aquatic and marsh vegetation of some lakes in the Muskoka and Parry Sound Districts of Ontario. A report prepared for the Toronto Fish and Game Protective Association, Toronto.

[2]Soper, J.H. 1948. A survey of the aquatic vegetation of Whitewater Lake, with special reference to its suitability to waterfowl. A report prepared for the Department of Lands and Forests of Ontario, Toronto. 13 pp. mimeo.

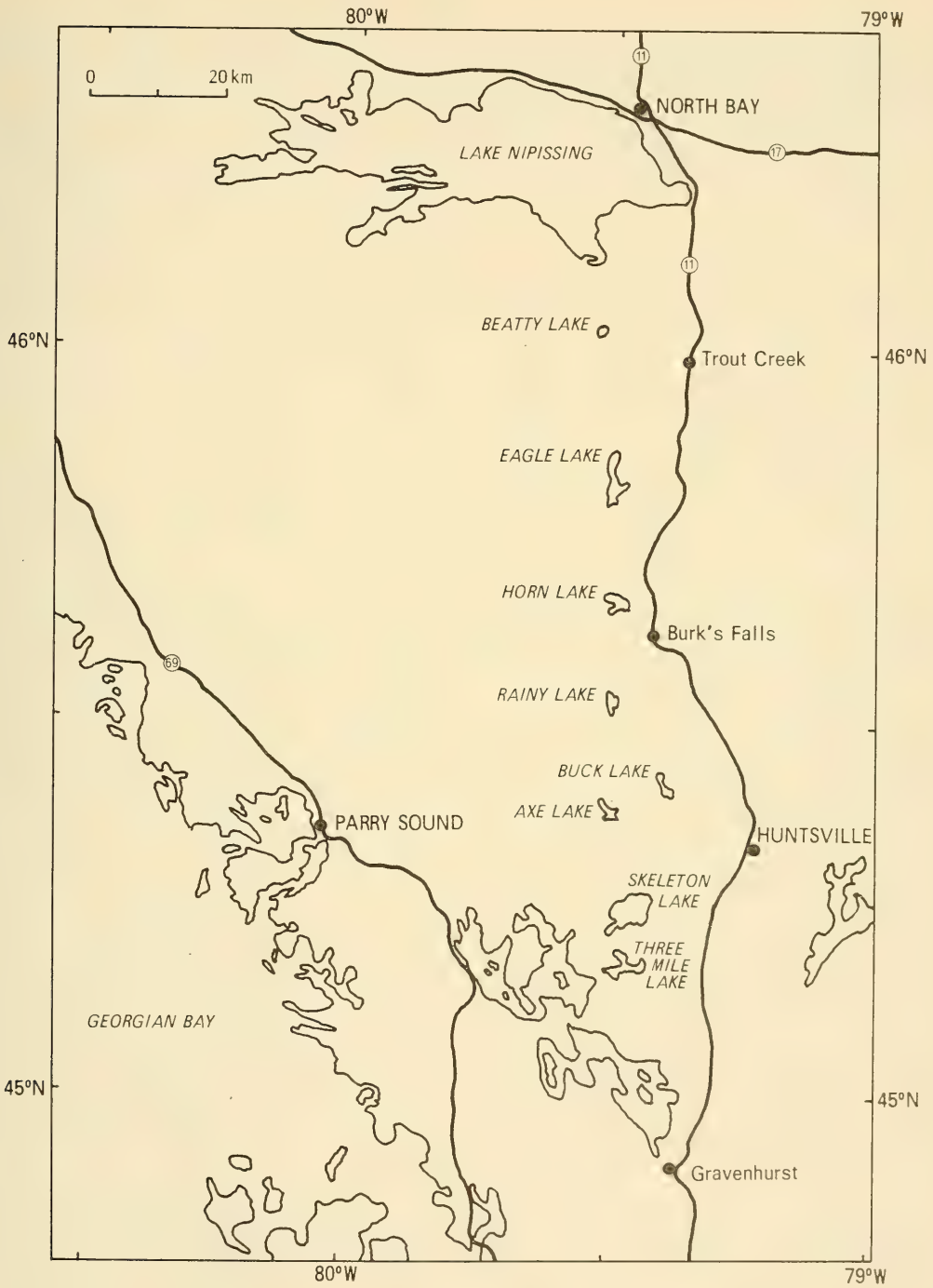

FIGURE 1. Location of the eight lakes sampled. Alternate names for some of these lakes are Rainy (Bartlett), Horn (Sollman), and Eagle (Machar).

Results

Forty-seven species were identified; this is 12 more than in 1953[1] (Table 1). There was a loss of a single species of Pondweed (*Potamogeton obtusifolius*). Five species present in the total flora were missing from two or more lakes; of these, four produce floating leaves and the fifth, a bladderwort, is chiefly subterranean but becomes noticeable when it produces yellow aerial flowers.

Discussion

Although the methods of sampling and recording the data differed, the two studies are comparable. The thorough survey, using a rowboat and rake to determine species present and using symbols to record on maps, produced a complete sampling for the parts of the lake visible from the surface. The recent survey used the same maps to check stretches of shallow water barren of plants in 1953 as well as areas in which a complex of species was found. These lakes have long stretches with few plants and the richest communities consisted of less than a dozen submersed and floating species. The numerous sites were surveyed by wading and swimming by a team of three but there is no reason to suggest that this was an incomplete survey of the shallow-water communities. The major difference in the surveys was in a more complete sampling of the deeper water using SCUBA equipment.

Of the plant species that were missing from two or more lakes, Batchelder (*Glyceria borealis*), a plant of small scattered patches, is difficult to identify after the release of seed, as is the bladderwort (*Utricularia cornuta*) if it is not in flower. One site of the latter was lost when a highway was built over a small part of Eagle Lake. Three others, the floating-leafed species, must be lost from the lake floras. These very visible species could not be overlooked and their loss was due to severe reduction of their populations, perhaps because of the increased use of outboard boat motors. The effect of the propellors would be similar to that of a mowing machine constantly cutting away the leaves. The number of buildings on one stretch of shore in Skeleton Lake increased from 102 in 1956–1960 to 177 in 1970 (Map 31 E/3 west, 1st edition, 1960 and new edition, 1974, National Topographical System, Canada). The decades between surveys were also the years of great water skiing activity in the Muskoka lakes.

Plants recorded only in the second survey were considered indicators of succession if found in two or more lakes. There has been no study to show whether Quillwort (*Isoetes macrospora*), Big-leaf Pondweed (*Potamogeton amplifolius*), and Arrowhead (*Sagittaria graminea*) could have increased dramatically in abundance in the interval. It is probable that these species were present but only in deep water and were not reached by the rake in the first sampling. For the same reason, six species — Quillwort, Arrowhead, Water moss (*Fontinalis* sp.), Bushy Pondweed (*Najas flexilis*), Big-leaf Pondweed, and Purple Bladderwort (*Utricularia purpurea*) — could also have been unrecorded. The last species was unrecorded in Lawrence Lake from a surface-based sampling (Rich et al. 1971) although it was common in part of the lake in 1976 (H. M. Dale and D. H. N. Spence, unpublished data).

Two of the new species, the bladderworts *U. resupinata* and *intermedia*, are obscure and could have been overlooked in 1953. The remaining species, however, are widespread shallow-water species, readily seen and identified. These species, therefore, have become more conspicuous or are new elements in the flora.

Along the southern shore of Three Mile Lake there is a horseshoe-shaped bay described by Shields[1] on his maps as containing a dozen species including six with floating leaves. This location was found to be unchanged in 1976 and matched the earlier description exactly. In contrast, a site along the western shore of Eagle Lake was marked clearly in 1953 as occupied by only Seven-angled Pipewort (*Eriocaulon septangular*) and Water Lobelia (*Lobelia dortmanna*), yet in 1976, a very conspicuous population of Narrow Floating-leaf Bur Reed (*Sparganium angustifolium*) was growing from a dense mat of the former two species. Also present were Needle Rush (*Eleocharis acicularis*), Rush (*Juncus pelocarpus*), and Waterwort (*Elatine minima*), members of the promiment widespread new species. Similarly in Horn Lake, Floating-heart and Floating-leaf Bur Reed had invaded a Pipewort-Lobelia mat.

In this type of sandy oligotrophic lake, Seven-angled Pipewort and Water Lobelia act as colonizing species and form patches that stabilize the coarse substrate, trap fine particles, and increase the organic matter of the substrate. These patches grow and coalesce, forming a modified environment suitable for colonization by Bur Reed, Waterworts, Rush, Needle Rush, and Floating-heart. Such a successional process in the vegetation produces a more complex vegetation by increasing the abundance of the rarer species.

Some differences between the surveys 23 yr apart may be explained by improved sampling methods: sampling with the use of a rake is less accurate than using SCUBA equipment. The floating-leafed Yellow Water Lily, Water Shield, and Floating-heart have been lost as a result of recreational use of the water; other species increased in abundance as a result of succession.

TABLE 1—Prescence (+) or abundance (R—rare, O—occasional, C—common, A—abundant) of aquatic macrophytes at the two sampling dates (1953, 1976) in each of eight lakes. Common names are from Fassett (1957)

	Three Mile		Skeleton Lake		Axe Lake		Buck Lake		Rainy Lake		Horn Lake		Eagle Lake		Beatty Lake	
Aquatic macrophytes	53	76	53	76	53	76	53	76	53	76	53	76	53	76	53	76
Water Moss (*Fontinalis* sp.)	+	R	+	R				O				C		O		
Quillwort (*Isoetes macrospora*)		O		C				C		A		C		A		+
Narrow Floating-leaf BurReed (*Sparganium angustifolium*)						R								C		+
Floating-leaf BurReed (*Sparganium fluctuans*)	+	R	+	O				O	+	O	+	C				
Big-leaf Pondweed (*Potamogeton amplifolius*)		A								C					+	+
Narrow-leafed Pondweed (*Potamogeton berchtoldii*)										R					+	
Ribbon-leaf Pondweed (*Potamogeton epihydrus*)	+	R	+	R	+	C	+	C		O	+			R		+
Variable Pondweed (*Potamogeton gramineus*)			+	R					+	C			+			
Floating Brownleaf (*Potamogeton natans*)	+	A	+	O			+	C			+	O	+	O		
Small Floating-leaf Pondweed (*Potamogeton oakesianus*)				R		C										
Pondweed (*Potamogeton obtusifolius*)									+							
Sago Pondweed (*Potamogeton pectinatus*)						R										
Clasping-leaf Pondweed (*Potamogeton richardsonii*)	+	R														
Robbins' Pondweed (*Potamogeton robbinsii*)		C														
Pondweed (*Potamogeton spirillus*)										O						
Bushy Pondweed (*Najas flexilis*)		R								R				R	+	+
Arrowhead rosettes (*Sagittaria graminea*)	+	C		R						A		A				
Canada Waterweed (*Elodea canadensis*)		R							+	C						
Wild Celery (*Vallisneria americana*)	+	C	+					C	+	A			+	C		
Batchelder (*Glyceria borealis*)	+	R					+		+							
Wild Rice (*Zizania aquatica*)	+	C														
Needle Rush (*Eleocharis acicularis*)								A		C				R		
Triangle Spike Rush (*Eleocharis robbinsii*)										R						
Water Bulrush (*Scirpus subterminalis*)						C						O				
Water Arum (*Calla palustris*)						R										
Seven-angled Pipewort (*Eriocaulon septangulare*)	+	O	+	C	+	C	+	A	+	C	+	A	+	A	+	+
Pickerel Weed (*Pontederia cordata*)	+	A	+		+	O	+	C	+	C	+	C	+	O	+	+
Bayonet Rush (*Juncus militaris*)							+	R	+	C	+				+	+
Rush (*Juncus pelocarpus*)							+	C		O		O	+	A		
Smartweed (*Polygonum amphibium*)									+	O				O		
Coontail (*Ceratophyllum demersum*)										O						
Water-shield (*Brasenia schreberi*)	+	C	+		+	R	+	O	+		+	O			+	
Yellow Water Lily (*Nuphar variegatum*)	+	O	+	R	+	O	+	O	+	O	+		+	R	+	
White Water Lily (*Nymphaea odorata*)	+	C	+	R	+	A	+	C	+	C	+	R	+	R	+	+
Creeping Spearwort (*Ranunculus reptans*)								R	+	C						
Water Starwort (*Callitriche heterophylla*)			+	R												
Waterwort (*Elatine minima*)										O				O		
Mares-tail (*Hippuris vulgaris*)			+	R												
Farwell's Milfoil (*Myriophyllum farwelli*)								R								
Milfoil (*Myriophyllum tenellum*)	+	R	+	C			+	C	+	A		C	+	C	+	+
Floating-heart (*Nymphoides cordatum*)	+	O	+		+	C	+	R	+		+	C				
Bladderwort (*Utricularia cornuta*)						C	+			R			+		+	
Bladderwort (*Utricularia gibba*)						O										
Bladderwort (*Utricularia intermedia*)						R		O					+			
Purple Bladderwort (*Utricularia purpurea*)						A		O		R						
Bladderwort (*Utricularia resupinata*)						A	+	C		C			+			+
Common Bladderwort (*Utricularia vulgaris*)			+	R	+	O		O							+	+
Water Lobelia (*Lobelia dortmanna*)	+		+	C	+	C	+	C	+	O	+	C	+	O	+	+
Number of changes/total records	6/22		7/20		10/19		12/25		18/32		9/17		13 22		8 17	

Acknowledgments

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Utricularia geminiscapa at Mer Bleue and Range Extensions in Eastern Canada*

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Haber, Erich. 1979. *Utricularia geminiscapa* at Mer Bleue and range extensions in eastern Canada. Canadian Field-Naturalist 93(4): 391–398.

The first Ontario occurrence of *Utricularia geminiscapa* at the Mer Bleue peat bog just east of Ottawa is reported. The main features that help to distinguish this species from *U. vulgaris* are tabulated and the problem of differentiating vegetative specimens of these two species is discussed. Additional range extensions for *U. geminiscapa* in eastern Canada of up to 600 km north of previously known localities are also reported and plotted on a distribution map of the species for North America.

Key Words: *Utricularia geminiscapa,* morphology, range extensions, Ontario, Canada.

The discovery of an Ontario locality for the bladderwort *Utricularia geminiscapa* occurred on one of several excursions made in 1973 to Mer Bleue, a peat bog situated approximately 16 km east of Parliament Hill, Ottawa (Figure 1). David R. Given from New Zealand, who was then a National Research Council fellow with the National Museum of Natural Sciences, and I were returning to our access point at the tip of Dolman Ridge when he noticed some flowering *Utricularia* in a small bog pool. Because it was obviously different from the *U. intermedia* we had seen earlier, we made a repre-

FIGURE 1. Mer Bleue peat bog, Ontario. Dolman Ridge is the northern spit of land extending into the bog from the left, Borthwick Ridge the southern.

*Contribution Number 9 to "Scientific and Cultural Studies of the Mer Bleue."

sentative collection. The identity of this species was readily determined at a later date because it had the characteristic chasmogamous and cleistogamous flowers (Figure 2a). Indeed the seeds from the cleistogamous flower capsules (Figure 2b) proved to be extremely characteristic and easily referable to *U. geminiscapa* by comparison with seed illustrations in Muenscher (1944). This initial encounter with *U. geminiscapa*, a species new to the province, prompted me to examine the morphology and habitat characteristics of this bladderwort in more detail and to search for additional range extensions in eastern Canada.

Morphological Distinctions

Although *U. geminiscapa* is usually quite distinct from *U. vulgaris*, particularly when flowers or capsules are present, purely vegetative specimens of these species may at times be difficult to identify unequivocably. The vegetative plumes of foliage of small specimens of *U. vulgaris* can approach in width those of *U. geminiscapa*, which are usually much narrower than those of *U. vulgaris*. The identification of vegetative material is further complicated by the lack of a clear-cut distinction in the form and nature of the leaf branching in the two species. In *U. geminiscapa*, the branching is dichotomous (Figure 3a) and is usually distinct from the pseudopinnate branching found in normal robust specimens of *U. vulgaris* (Figure 3d). This distinction, however, is not always evident because smaller specimens of *U. vulgaris* may exhibit leaf branching similar to that of *U. geminiscapa*. Such vegetative characteristics are often almost obliterated by careless mounting procedures in the preparation of herbarium specimens. Fresh specimens should be float-mounted prior to drying to display clearly the nature of the leaf branching. Several features that can be used to distinguish these two species are given in Table 1.

The supposed absence of marginal leaf spines in *U. geminiscapa* has been used as a criterion for distinguishing this species from *U. vulgaris* which is characteristically spinulose-margined (Muenscher 1944; Fassett 1957; Roland and Smith 1969). The fresh specimens from the Mer Bleue locality leave no doubt that the leaf segments can be spinulose-margined (Figure 3a). The abundant herbarium specimens from the Farnham bog (Missisquoi County, Quebec) also confirm this observation. The leaves of the winter buds are also slightly spinulose and are terete in section, as in normal leaves. They form a loose, one-sided aggregate and maintain their green color when in bud (Figure 3b). In *U. vulgaris* the bud leaves are usually conspicuously flattened, highly dichotomized and very spinulose with the whole bud appearing grayish-white owing to the abundance of the solitary or fasciculate spines. The bud forms a dense, round to

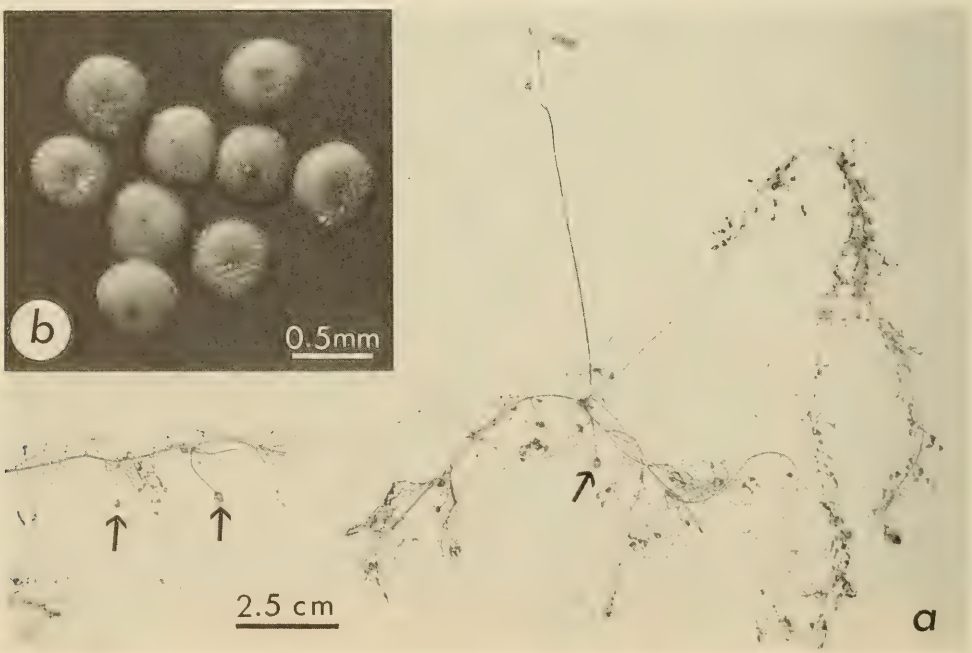

FIGURE 2. *Utricularia geminiscapa:* (a) whole plant with normal flowers and cleistogamous capsules, the latter indicated by arrows; (b) seeds from cleistogamous capsules.

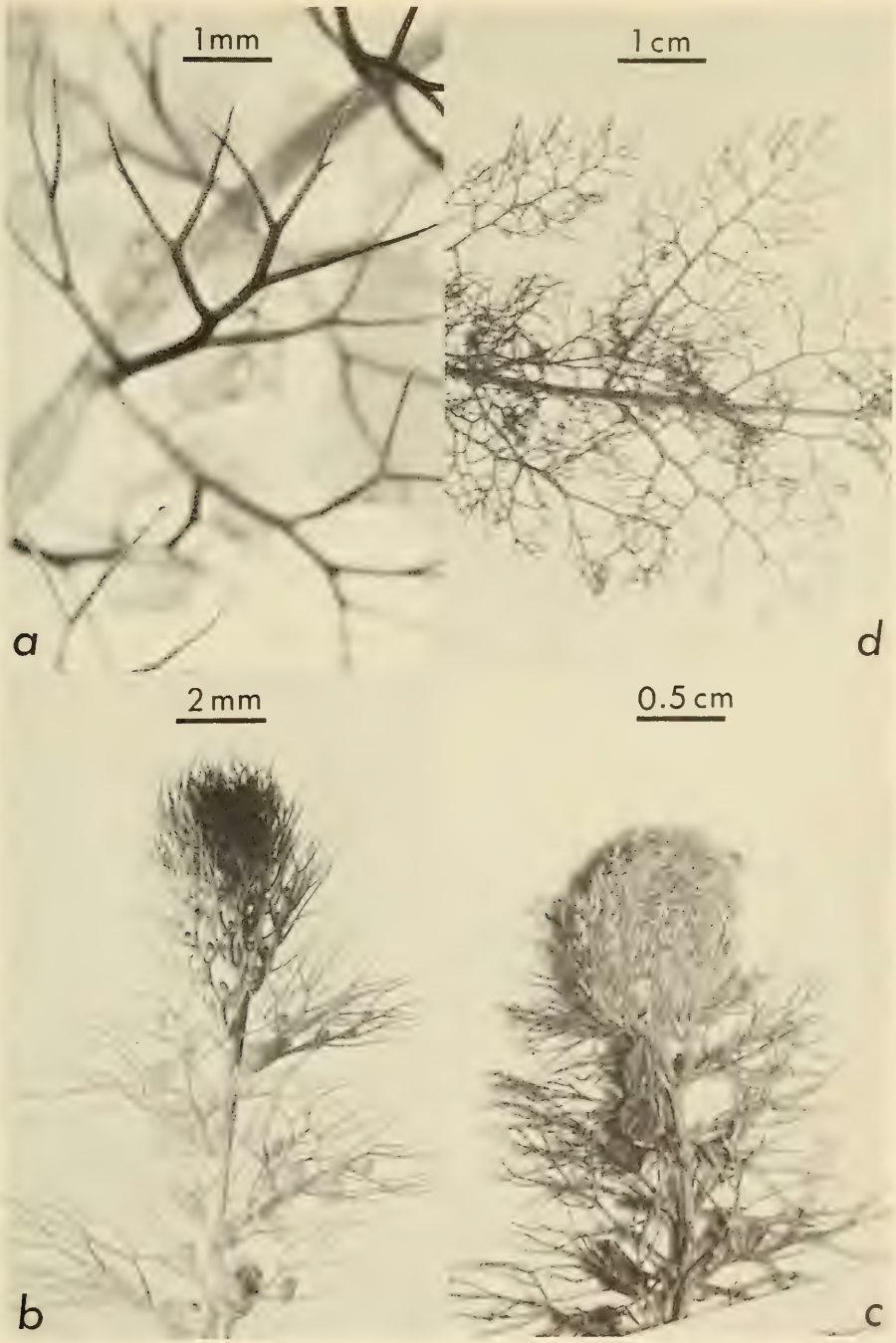

FIGURE 3. Leaf branching pattern and winter bud characteristics in *Utricularia. Utricularia geminiscapa:* (a) spiny leaf segments in a fresh specimen; (b) portion of leafy plume of a fresh specimen with terminal winter bud (the one-sided aspect of the bud is not evident in this photo). *Utricularia vulgaris:* (c) portion of leafy plume of a dried specimen with terminal, highly spinulose winter bud; (d) leaf branching pattern in a dried specimen.

TABLE 1—Characters useful in distinguishing the two species of *Utricularia*

Character	*U. geminiscapa*	*U. vulgaris*
Aerial scapes	filiform, without scales	coarse, with several scales
Flowers	corolla 0.5–0.8 cm long	corolla 1.5–2.5 cm long
Flower bracts	without basal lobes	with basal lobes
Cleistogamous flowers	present, apetalous, scattered along stem axils and producing abundant seeds	absent
Seeds	discoid	angular with many facets
Foliage plumes	1.0–3.5 cm in diameter	3–12 cm in diameter
Leaf branching	dichotomous	dichotomous to usually ± pinnate
Leaf segments	long acuminate with or without terminal spine(s); margins glabrous to sparingly spinulose	spine-tipped with single or fasciculate spines; margins ± abundantly spinulose
Winter buds	0.2–0.5 cm in diameter, green, one-sided; leaf segments terete, glabrous to sparingly spinulose	1–3 cm long; dense, round to oval mass, occasionally lobed; leaf segments; flattened and highly spinulose

oval, sometimes lobed mass of bud leaves (Figure 3c). The best way of ensuring that vegetative specimens of these two species can be identified with some certainty is to collect from a given locality samples including as wide a size variation of the vegetative plumes as possible.

Although *U. intermedia* also occurs in bog pools at Mer Bleue, it can be readily distinguished from *U. geminiscapa* and as well from *U. vulgaris* by its flattened, dichotomous branching and by the presence of a mid-vein in the leaf segments.

Characteristics of the Mer Bleue Locality

A search of herbaria in Ontario and Quebec indicated that the Mer Bleue site is probably the first verified locality for *U. geminiscapa* in Ontario (see also Morris 1922). In order to gain an insight into its frequency of occurrence at the bog, I returned during October and early November of 1978. The water level in the fall of 1978 was somewhat lower than when the first collection was made (17 July 1973) with the result that the original shallow pool was no longer present. In its place were several small potholes with little standing water and no discernible evidence of the bladderwort. The yearly and seasonal water table fluctuations, therefore, appear to have some influence on the localized development of *U. geminiscapa* in shallow bog pools. Presumably low water levels would not eradicate the species from such shallow, superficial bog pools because of the presence of the resistant winter buds which could lie dormant in the moist *Sphagnum* mat until open water was again available.

Potential sites for the bladderwort could be readily located by inspecting aerial photographs of Mer Bleue. The pools of varying size that are evident on the aerial photographs are distributed primarily in the vicinity of the wooded islands in the central region of the bog (see Figure 4). Most if not all of these are bomb craters formed when the bog was used as a practice bombing range between 1942 and 1945 (S. Ashley, 1979. The Mer Bleue — The evolution of an urban bog. An oral history of the Mer Bleue and surrounding communities. An in-house publication, National Capital Commission, Ottawa, Ontario; Freeman 1969). The latest aerial photographs taken in 1978 (Figure 4 in part) indicate that virtually all of the pools evident on the earliest photographs taken in 1945 are still present.

Five of the six bomb crater pools surveyed briefly in the fall of 1978 contained the bladderwort (sites 6, 9, 12, 13, 14; Figure 4). One of these pools (site 14) located in a predominantly open area with scattered Tamarack (*Larix laricina*) is illustrated in Figure 5. These deep, bomb crater pools contain few aquatics and are usually fringed by a relatively firm *Sphagnum* mat stabilized by ericoid shrubs, in particular by Leatherleaf (*Chamaedaphne calyculata*). The presence of *U. geminiscapa* in nearly every pool sampled would indicate that the unorthodox use of the bog as a bombing range may have benefited the species by increasing the number of habitats suitable for colonization. These deep pools would also serve as favored habitats for this bladderwort because low water-table levels would not eliminate such pools.

Water samples were collected from each pool surveyed and the pH compared with bog water obtained from within the bog mat at various sites. The location of these samples is indicated in Figure 4. Summarized in Table 2 are the pH measurements which were obtained in the laboratory at room temperature with a Beckman 180 pocket pH meter. The pH values obtained ranged from 3.9 to 6.1. Sites 1–5 and 7 with pH values ranging from 3.9–4.1 are perhaps most representative for the bog mat, judging from reports by Terasmae and Mott (1964, pH 3.8)

FIGURE 4. Original collection locality for *Utricularia geminiscapa* (asterisk). It was subsequently found at sites 6, 9, 12, 13, 14. Each numbered site represents a sample locality for pH determinations.

FIGURE 5. Northward view of one of the deep, bomb crater pools (site 14) in which *Utricularia geminiscapa* was found. Photographed in the fall of 1978.

TABLE 2—Acidity (pH values) of pools and bog mat at various sites in the Mer Bleue peat bog

	Site	pH
1	open mat	4.1
2	open mat	4.0
3	forested bog	3.9
4	forested bog	3.9
5	sedge zone	4.0
6	bog pool	4.5
7	sedge meadow	4.1
8	bog pool	6.1
9	bog pool	5.4
10	open mat	4.7
11	sedge-leatherleaf mat	4.6
12	bog pool	4.9
13	bog pool	4.9
14	bog pool	4.7
15	sedge-leatherleaf mat	4.4
16	marginal channel (lagg)	4.6

and Joyal (1971, pH 3.8 and 3.9). The bog pools ranging from 4.5 to 6.1 had consistently higher values than sites in the bog mat. The remaining sites (10, 11, 15, 16) also had higher values (4.4–4.7) than the more usual value of about 3.9 for the bog mat. Measurements previously taken in June 1974 in the region east of site 16 and extending to the first small island yielded pH values between 5.1 and 5.4.

The significance of the higher pH levels of the bomb crater pools and other sites in the central region of the bog is not clear until one also takes into account the localized enrichment of the bog flora that occurs in this area. Some of the species that occur here are also common elements of the peripheral eutrophic zone. This central, primarily treeless, mesotrophic region is represented in Figure 4 as the dark elongate band extending eastward from the southeastern tip of Dolman Ridge to the first small island and again as the major band surrounding and trailing eastward from the large central islands. Cat-tails (*Typha latifolia*), Bogbean (*Menyanthes trifoliata*), Water Arum (*Calla palustris*), Chain Fern (*Woodwardia virginica*), and *Scheuchzeria palustris* occur in this mesotrophic region. The White Fringed Orchid (*Platanthera blephariglottis*) is also common along the southern, forested edge of this area east of the large islands (see also Lafontaine 1971). Speckled Alder (*Alnus rugosa*), a common bog fringe species, occupies a sizable shrubby area between the western ends of the two large islands, and species of sedges form extensive meadows in this central region and add to the fen-like appearance.

The generally higher pH values and apparent mesotrophic nature of this central region may be directly related to the ground-water levels and shallow nature of the underlying central basin (maximum depth about 2 m) (see map of peat depths in Nyström and Anrep 1909). During periods of drought as in 1877 and 1878 (The Ottawa Naturalist 1888, 2: 74) and low ground-water levels as in 1970 and 1974 (M. Bik, 1975. *In* Proceedings of the Mer Bleue Seminar. An in-house publication, National Capital Commission and Central Research Forest, Ottawa, Ontario), the water level would decrease over the central shallow basin and aeration and substrate temperatures would increase resulting in a temporary eutrophication. Subsequent periods of high ground-water levels would cause a reversal of these conditions. This mesotrophic zone lying between two deeper basins (maximum depths about 6 m) may in effect represent a tension zone providing suitable habitats for certain species of plants. The relatively large band of *Typha* within this zone east of the large islands may represent, together with the peripheral *Typha* zone, the remnants of an earlier, more extensive marshland habitat. In Camfield's pollen diagram (1969), *Typha* pollen was most abundant in one of the oldest zones in her Mer Bleue core.

Although the earliest organic sediments in Mer Bleue are approximately 7500 yr old (Camfield 1969), the arrival of *U. geminiscapa* probably dates to a much more recent time commensurate with the formation of suitably acidic bog pools. Throughout its range this species occurs most commonly in quiet, acidic waters and in particular in bog pools. The difference in habitat preferences between *U. geminiscapa* and *U. vulgaris* is readily apparent at Mer Bleue where the latter occurs in shallow ditches adjacent to the bog but not directly influenced by the acid *Sphagnum* mat. Throughout its widespread range, *U. vulgaris* occurs in ponds, lakesides, and sluggish streams.

The occurrence of *U. geminiscapa* at Mer Bleue is simply one more interesting species addition to an increasing list of novelties either first described from the bog or represented regionally only at this locality. Additional information regarding various aspects of this locality can be found in the papers by Baldwin and Mosquin (1969), Corbet and Walley (1969), Dunston (1970), Smith (1970a, b), Hobson (1970), Ouellet et al. (1976), and Small (1976).

Range Extensions in Eastern Canada

A search of herbaria in Ontario and Quebec (CAN, DAO, TRT, QFA, QSA, MT, MTMG, and SFS; acronyms according to Holmgren and Keuken (1974)) resulted in the validation of specimens from seven Canadian localities in addition to the Mer Bleue record. The eight validated localities of *U. geminiscapa* plotted on the map in Figure 6 are as follows:

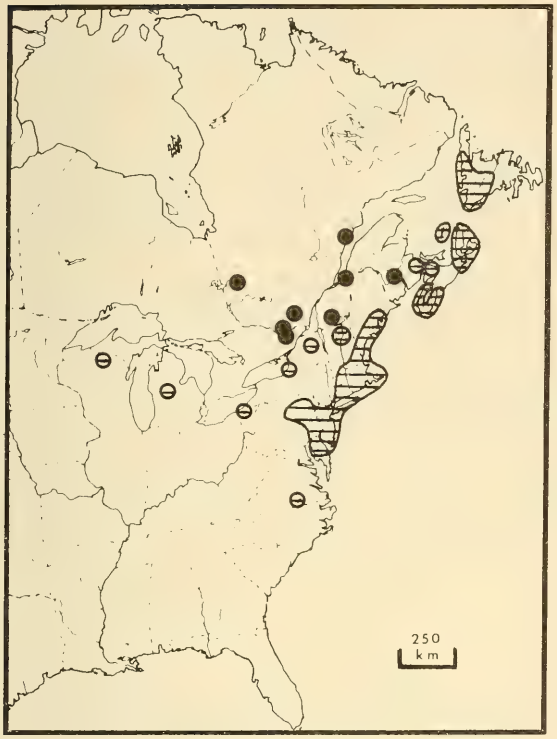

FIGURE 6. North American distribution of *Utricularia geminiscapa*. The generalized range of this species, derived from maps published by Fernald (1933), Thomson (1940), Muenscher (1944), and Roland and Smith (1969), is represented by the hatched areas. The solid dots represent new localities based on verified specimens.

Ontario: Mer Bleue peat bog, 45°24′N, 75°30′W, The Regional Municipality of Ottawa-Carleton, bog pool, *E. Haber & D. R. Given 1963*, 17 July 1973 (CAN).

Quebec: plaine de la Rivière Ouelle, cté Kamouraska, *E. Campagna*, 13 July 1928 (QSA); tourbière de Farnham, cté Missisquoi, *M. Raymond*, 20 Aug. 1933 (CAN) [the earliest of many collections from this site]; L. Hibou, 5 mi [3 km] southwest of Taschereau, W. Abitibi Co., small boggy lake, *W. K. W. Baldwin & A. J. Breitung 4287*, 29 Aug. 1952 (CAN); entre St-Faustin et Lac Supérieur, Lac artificiel Dupré, cté Terrebone, *Frère Rolland-Germain 422*, 23 July 1957 (CAN); Ilets-Jérémie, cté Saguenay, dans les petites mares, tourbière à cypéracées, *J. Cayouette 73-719*, 14 Aug. 1973 (QFA); Hopkins Hole, between Ramsay L. and Hawley L., Gatineau Pk., Gatineau Co., *A. & J. Reddoch*, 19 Aug. 1978 (CAN).

The most northerly range extensions for *U. geminiscapa* occur at Lake Hibou (48°38′N, 78°48′W) and at Ilets-Jérémie (48°53′N, 68°48′W) in Quebec. Both localities are approximately 600 km north of previously documented localities in upper New York State and Maine, respectively. Although the Lake Hibou specimens were originally determined as *U. minor* by Baldwin, they are sufficiently characteristic in spite of their vegetative condition that they were validated as *U. geminiscapa*.

A number of perplexing collections made by Frère Rolland-Germain at Lake Monroe in Montcalm County, Quebec and identified as *U. geminiscapa* (CAN, MT, SFS) are considered to be merely small vegetative specimens of *U. vulgaris*. This decision was reached only after seeing a whole series of vegetative specimens of *U. vulgaris* from the same locality at the Marie-Victorin herbarium (MT). These specimens ranged from the more typical large-plumed specimens to those that were much reduced in size approaching *U. geminiscapa* in appearance.

Utricularia geminiscapa may indeed be much more widely spread in eastern North America than is at present documented. The vegetative characteristics of *U. vulgaris* such as overall size of leaf plumes, manner of leaf branching, form and pubescence of winter bud leaves, and leaf pubescence are extremely variable and require further investigation over the whole range of this cosmopolitan species. The cultivation of this species under controlled environmental conditions may prove useful in accounting for some of the observed natural variation.

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Movements of Sympatric Species of Snakes at Amherstburg, Ontario

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In order to investigate the movements of Butler's Garter Snakes (*Thamnophis butleri*), Eastern Garter Snakes (*Thamnophis sirtalis sirtalis*), Brown Snakes (*Storeria dekayi*), and Eastern Fox Snakes (*Elaphe vulpina gloydi*), we systematically searched for, captured, and individually marked by scale-clipping these species. Recaptured snakes were found to have moved relatively short distances, with over 50% of marked snakes being recaptured less than 50 m from the initial point of capture after various recapture intervals. There was no evidence of large-scale emigration of snakes from areas inhabited in the early spring. For all species, only a small percentage of the population demonstrated relatively long-distance (about 400 m) unidirectional movements. There were no consistent differences in movements between sexes. More female *T. butleri* were recaptured than males. No directional trends in movements were observed, but a tendency to avoid road-crossing was noted for *T. butleri*. In cases of multiple recapture, minimum activity ranges are presented.

Key Words: *Thamnophis butleri, Thamnophis s. sirtalis, Storeria dekayi, Elaphe vulpina gloydi,* movements, activity range, southwestern Ontario.

Gregory and Stewart (1975) described dispersal of the Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) following spring emergence from karst hibernacula in the Interlake District of Manitoba. There are no other published data on the movements of snakes in Canada, although these are an important part of general ecological understanding and are critical for the conservation of populations of rare animals.

The purpose of our study was to describe movements of four sympatric species of snakes and to analyze these with respect to the extent of suitable habitat required, and the sizes of areas that must be protected to ensure the survival of populations. The study area, 2.4 km NE of Amherstburg, Essex County, Ontario, has been described previously (Freedman and Catling 1978). Two of the species studied, Butler's Garter Snake (*Thamnophis butleri*) and the Eastern Fox Snake (*Elaphe vulpina gloydi*) are considered rare or endangered in Canada (Cook 1970, 1977; Gregory 1977). The other two species, the Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) and the Brown Snake (*Storeria dekayi*), are widespread and common.

Methods

We searched systematically for snakes along predetermined census routes during a series of visits to the study area in the spring and summer of 1976 (14 and 30 May, 15 June, 10 and 24 July). All snakes captured were marked by clipping scales (Freedman and Catling 1978), and the point of capture was recorded on large-scale aerial photographs (1 cm = 10 m). Sex and total length were also recorded for each snake to allow comparisons among sexes and size classes (Freedman and Catling 1978). All snakes were released where captured within 15 min. Young snakes less than 1 yr old and young-of-the-year (defined by body length) were difficult to mark by scale-clipping, and were not included. Snakes less than 1 yr old were relatively uncommon (Freedman and Catling 1978).

For all captured snakes the distance between the recapture and the most recent point of capture was determined to give a minimum distance travelled. In cases of more than one recapture of an individual snake, these minimum distances were also summed to give a total minimum distance travelled. In the cases of multiple recapture, minimum activity ranges were calculated from the areas enclosed by the joined points of capture and recapture. We also considered the possibility that roads could restrict movements of snakes; we noted whether snakes crossed an open 10-m-wide gravel road.

Results and Discussion

Out of a total of 250 individuals of *T. butleri*, 72 *T. s. sirtalis*, and 102 *S. dekayi*, a minimum of 10 recaptures was made per species, and some individuals were recaptured more than once. All of these species exhibited a strong tendency for relatively short-distance movements, with more than 50% of all marked individuals being recaptured less than 50 m from the initial point of capture after various intervals

of time (Figures 1–3). In general, total distance moved by all three species increased the longer the time interval between initial capture and subsequent recapture(s). This tendency is illustrated for *T. butleri* (Figure 1b–d), for which there were 25 recaptures.

For each of the three species, there were no consistent differences in movement between the sexes (Table 1). Although female *S. dekayi* appear to move less than males, the sample of males is only two. More female *T. butleri* were recaptured than males (Table 1), even though the proportion of males in the population was about 0.56 (Freedman and Catling 1978). Possibly female *T. butleri* are less mobile and have a greater tendency to bask in the open (Gregory 1975) and are consequently more often captured than males.

The *S. dekayi* covering the greatest distances were a male 31 cm long covering 374 m in 30 d, and a gravid female 39 cm long covering 226 m in 30 d, both single recaptures. The *T. butleri* covering the greatest

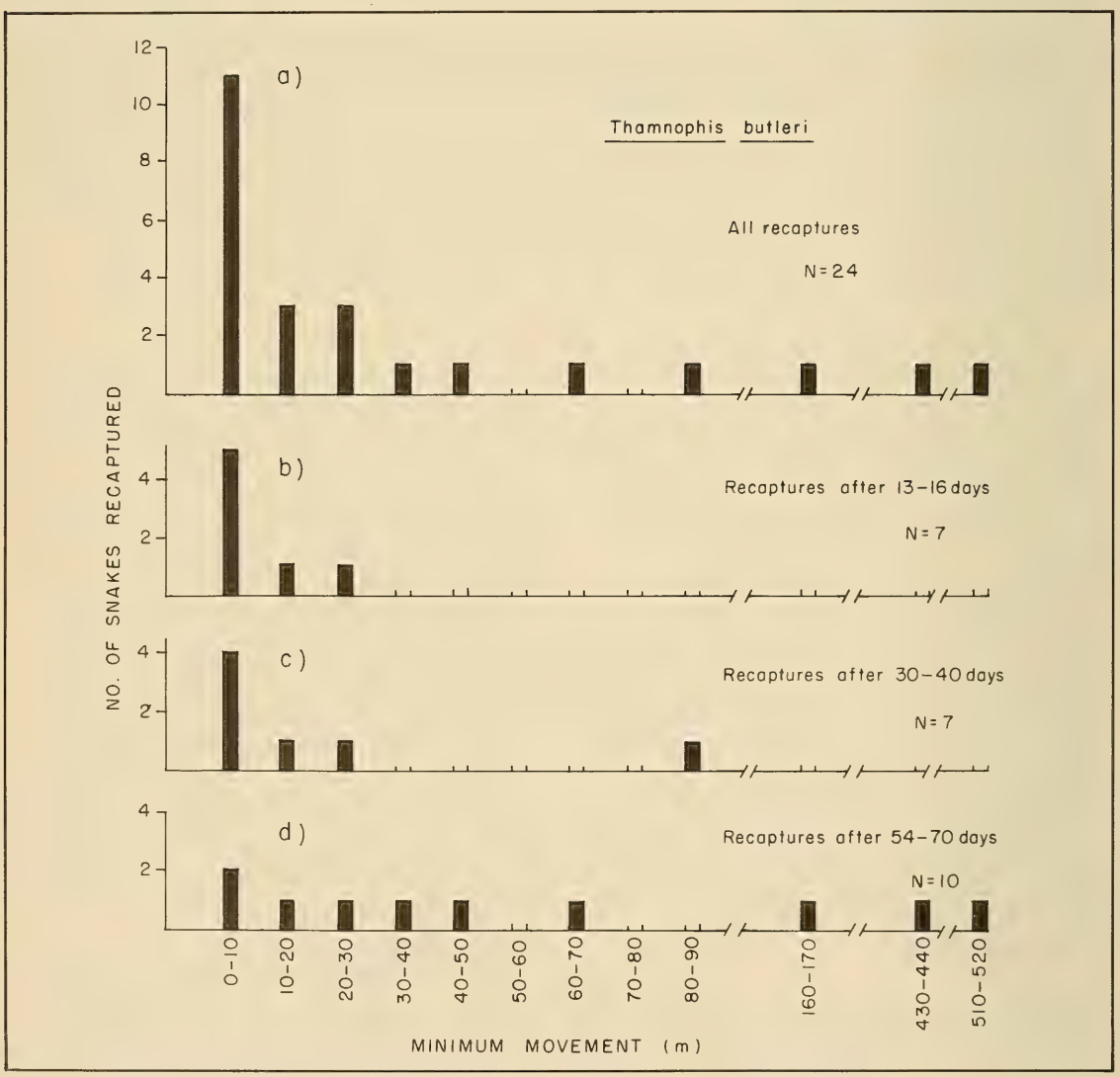

FIGURE 1. Minimum movements of marked *Thamnophis butleri*: (a) all recaptures during 1976; (b, c, d) recaptures at specific time intervals following release. Data include 20 individuals, of which two were recaptured twice and one was recaptured three times.

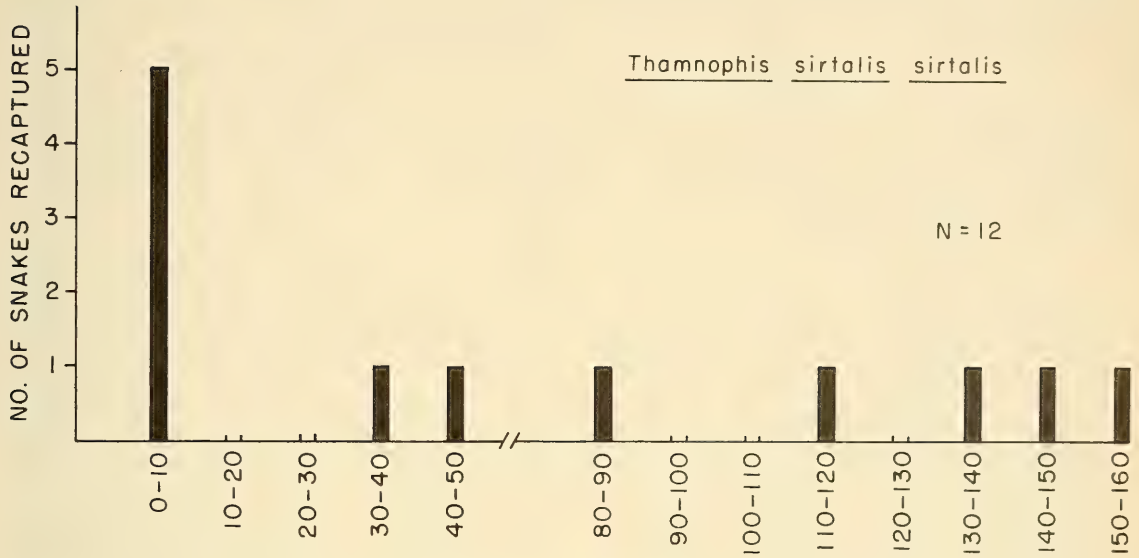

FIGURE 2. Minimum movements of marked *Thamnophis sirtalis sirtalis* from all 1976 recaptures. Data include 11 individuals, one recaptured twice.

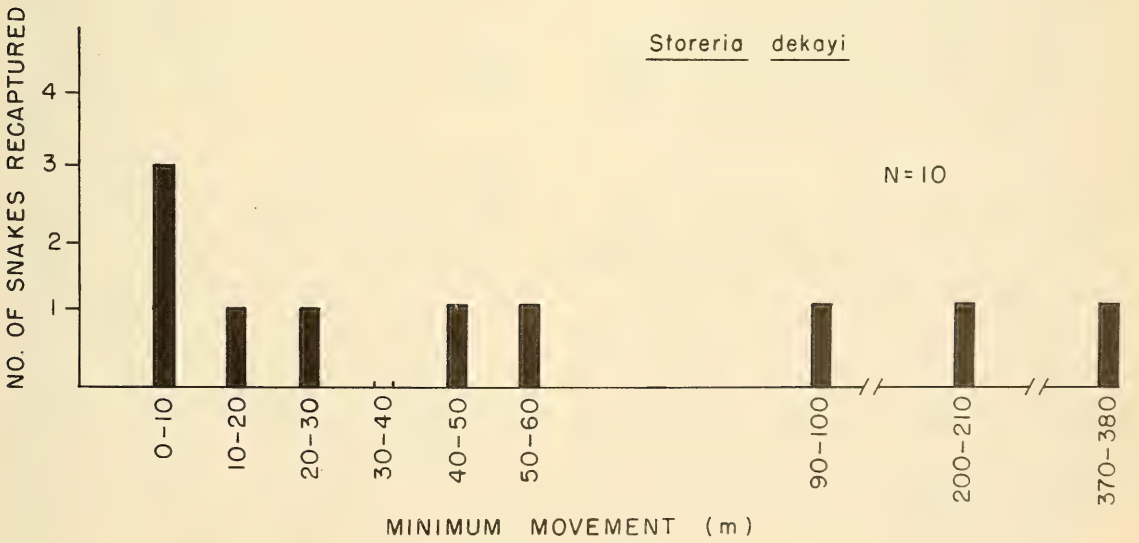

FIGURE 3. Minimum movements of marked *Storeria dekayi* from all 1976 recaptures. Data include eight individuals, two of which were recaptured twice.

TABLE 1—Sex-specific minimum movements for marked individuals of three species of snakes

Species	Minimum distance travelled (m)					
	Males			Females		
	Mean ± SE	n	Range	Mean ± SE	n	Range
Thamnophis butleri	92 ± 59	5	< 10–433	67 ± 28	19	< 10–226
Thamnophis sirtalis	51 ± 28	6	< 10–147	75 ± 29	5	< 10–153
Storeria dekayi	197 ± 177	2	15–374	59 ± 34	6	< 10–517

distances were also single recaptures, including a 31-cm male covering 433 m in 70 d and a 47-cm gravid female covering 517 m in 70 d. The longest distance moved by *T. s. sirtalis* involved a 63-cm female which covered 153 m in 27 d.

Generally, there were no directional trends in the movements observed. *Thamnophis s. sirtalis* moved only within a restricted and relatively moist area, where these snakes were abundant. Long-distance movements of *S. dekayi* involved moving along a moist roadside ditch. It might be assumed that the relative scarcity of *T. butleri* in midsummer in the dry quarry section of the study area was the result of emigration. The recapture data do not, however, support this assumption. Of the 17 *T. butleri* marked in a dry upland area, 14 were recaptured again in the immediate vicinity, and eight of these were recaptured more than 40 d after initial capture. Only three of the recaptured snakes had moved to lower moist sites. Two of these, recaptured 70 d after initial capture, had moved over 400 m to wetter ground. The fact that *T. butleri* did not become conspicuously more abundant in moist places in the western portion of the study area in midsummer suggests that only a small percentage of the population was involved in large-scale emigration.

Carpenter (1952) studied a large population of *T. butleri* at a site in Michigan, and found minimum movements of 26 snakes to average 115 m. He also found that females moved 65% farther than males. No directional trends were exhibited in the movements of snakes in Carpenter's study.

R. J. Planck and J. T. Planck (1977, unpublished report, Department of Supplies and Services, Ottawa), in a mark-recapture study of *T. butleri* in southwestern Ontario, found this species to be relatively sedentary. They found a maximum displacement of only 25 m among nine males, and of 19 m among 19 females. In addition they noted an apparent lack of directional trend.

Data on movements of two other species of *Thamnophis* (*T. radix* and *T. brachystoma*), which have strong taxonomic affinities to *T. butleri* (Conant 1950), may also serve as comparisons with data on the latter species. Siebert and Hagen (1947), working at a site in Illinois, found *T. radix* to be relatively sedentary, with 83% of their 41 snake recoveries showing minimum movements of less than 46 m, and only one snake moving farther than 90 m. Klingerer (1957), working with *T. brachystoma* in Pennsylvania, also offered evidence for small activity areas, although Asplund (1963) thought that his later work provided evidence to the contrary.

Carpenter (1952) recorded movements of *T. s. sirtalis*, which were sympatric with *T. butleri* at his Michigan site. He found minimum movements of 127 *T. s. sirtalis* to average 58 m, about half the distance averaged by *T. butleri*. No differences in movements were noted between sexes, nor was any directional trend observed.

Fitch (1965) described movements of *T. s. sirtalis* in Kansas, reporting that the minimum distance travelled by males averaged 532 m, and by females 347 m. He also noted a lack of directional trend in the movements. Fitch also reported that the minimum distances travelled tended to increase as the time interval between capture and recapture increased.

Gregory and Stewart (1975), working in the Interlake region of Manitoba, reported dispersal data for 26 marked individuals of *T. sirtalis parietalis*. The minimum movements reported (mean ± SE = 10.7 ± 0.73 km, range = 4.3 to 17.7 km) were much longer than those found in the present study for *T. s. sirtalis*. No differences relating to sex were observed. These authors found the movements of their marked snakes to be strongly directional between karst hibernacula and summer feeding grounds in nearby marshes. The spatial separation of the hibernacula and the feeding habitat of these snakes presumably accounts for the relatively long distances travelled. But no such spatial separation of hibernacula and feeding areas was apparent at our site.

Noble and Clausen (1936) reported that little movement of *S. dekayi* occurred if captured individuals were released close to the point of capture; however, if they were released at another locality, they tended to return to the original site, moving up to 1200 m in 7 d.

Only one recapture was made by us of a marked *Elaphe vulpina gloydi*, out of a total of 33 marked. This individual, marked in 1976 and recaptured in 1977, travelled a minimum distance of 250 m. Rivard (1976) reported recapturing 10 *E. vulpina gloydi* at Point Pelee National Park, Ontario. These were all recaptured at or within several metres of their original point of capture up to 25 d later. Rivard (1976) cited previous park studies, but noted that they provided little additional information on *E. vulpina gloydi* activity. Fitch (1963) found minimum movements of up to 1000 m in the congeneric Black Rat Snake (*Elaphe o. obsoleta*) at a site in Kansas, although most recorded movements were less than 200 m.

Various studies have suggested that most snakes do not wander randomly over the landscape, but rather inhabit restricted areas, which have been referred to as "home ranges" or "activity ranges" (Stickel and Cope 1947; Carpenter 1952; Fitch 1963). Stickel and Cope (1947) calculated that *E. o. obsoleta* and the Northern Black Racer (*Coluber c. constrictor*) at their sites could easily cross their home ranges in 3 h at a normal crawling speed. They noted that relatively long-distance, unidirectional movements do occasionally occur, but that they represent exceptional events. Similarly, Hirth et al. (1969) reported that most recaptures of marked snakes occurred within about 1 km of a hibernaculum in Utah. Noble and Clausen's (1936) evidence for homing behavior of *S. dekayi* also suggests affinity for a specific area.

The longest distances travelled by snakes in our study area represent single recaptures, and suggest relatively long-distance unidirectional movements. Possibly a small percentage of the population is comprised of transients. The few cases of two or three recaptures of a single individual, and minimum activity range, are summarized in Table 2.

Carpenter (1952) estimated average and maximum activity ranges of 8000 m² and 17 000 m² for *T. s. sirtalis*, 3000 m² and 9000 m² for *T. butleri* at a site in Michigan where they were sympatric. Fitch (1965), working at a site in Kansas, calculated an activity range of 14.2 ha (142 000 m²) for male *T. s. sirtalis*, and 9.2 ha (92 000 m²) for females. Although Gregory and Stewart (1975) did not present estimates of activity ranges for Manitoba Interlake *T. sirtalis parietalis*, the long distances travelled by marked snakes during their dispersal movements from karst hibernacula (previously described) would suggest very large activity ranges relative to other observations for *Thamnophis* spp. Finally, Fitch (1963) calculated activity ranges for *Elaphe o. obsoleta*, a congeneric with *E. vulpina gloydi*, and found these to be 11.7 ha for male snakes and 9.3 ha for females.

Although our data (no crossings of a 10-m-wide gravel road were observed for five *T. butleri*) are too few to be statistically significant, we suspect that there is a tendency for snakes to avoid crossing roads. The abilities of both *S. dekayi* and *T. butleri* to persist in isolated parks and vacant lots surrounded by urban development (Logier 1958; Campbell 1971) suggest that roads and other habitat discontinuities such as woodlands (Carpenter 1952) are restrictive to movements of a large proportion of the populations of these species. This theory deserves more rigorous testing because it has important implications with respect to road construction in parks and nature reserves. In addition to restricting movements, roads may contribute to mortality owing to traffic and to increased exposure to natural predation.

TABLE 2—Minimum activity ranges of marked snakes having more than one recapture. Except for the male *T. s. sirtalis*, all the snakes were females. Data collected near Amherstburg, Ontario in 1976

Species	TL*, cm	Marked	Recaptured	Area of activity m²
T. butleri	47.0	14 May	30 May 10 July	50
T. butleri	37.5	14 May	30 May 10 July	50
T. butleri	47.0	14 May	30 May 15 June 24 July	600
T. s. sirtalis	50.0	30 May	15 June 10 July	2400
S. dekayi	34.4	30 May	15 June 10 July	50
S. dekayi	39.5	15 June	10 July 24 July	1200

*TL = Total length.

Acknowledgments

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Winter Feeding by Porcupines in Montane Forests of Southwestern Alberta

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Past feeding on the inner bark of Douglas Fir (*Pseudotsuga menziesii*) and Limber Pine (*Pinus flexilis*) by Porcupines (*Erethizon dorsatum*) was examined on two areas of southwestern Alberta. Measurements of annual growth from increment cores were used to estimate the previous sizes of trees. In conjunction with the ages of feeding scars, these estimates provided a means of determining the physical characteristics of the trees used by Porcupines over a 20-yr period. Of the three community types available to Porcupines, pure stands of Douglas Fir in leeward situations were preferred. Although Porcupines fed in the larger, faster growing trees within this community on both study areas, the average diameter of the boles of used trees differed between study areas. This may be related to a possible relaxation of the preference for larger trees on the more extensively used area.

Key Words: Porcupine, *Erethizon dorsatum*, food habits, Alberta.

Concurrent with the cessation of plant growth and the onset of breeding in autumn, Porcupines (*Erethizon dorsatum*) move to areas more heavily wooded than their summer ranges and begin to feed on the inner bark of woody plants and the foliage of several species of conifers (Gabrielson and Horn 1930; Curtis and Wilson 1953; Brander 1973). When feeding on inner bark, Porcupines eat the cambium and phloem and expose the underlying xylem. During subsequent growth periods, exposed xylem is slowly covered by the centripetal growth of callus tissue formed from the surrounding cambium (Brown 1971). The resulting scars are a semi-permanent record of the amount and location of bark removed and the annuli in the new xylem relate the year in which feeding occurred.

Only two published studies (Spencer 1964; Storm and Halvorson 1967) have taken advantage of the temporal information available in feeding scars; neither were directly concerned with the food habits of Porcupines. I have studied the distribution of feeding scars within and among trees to determine the general pattern of forest use by Porcupines on two study areas in southwestern Alberta. This report documents the physical characteristics of the trees used by Porcupines during a 20-yr period, and the location of feeding within those trees.

Study Areas and Methods

Two study areas were examined, both located on the eastern fringes of the foothills of the Front Ranges of the Rocky Mountains. The Zoratti study area (49°27′N, 114°04′W), 11 km W of Pincher Creek, Alberta, covers an area of 36.3 ha and varies in elevation from 1210 to 1320 m. The Skelton study area (49°34′N, 114°13′W), 16 km NW of the Zoratti site, encompasses 115.4 ha and ranges in elevation from 1180 to 1360 m.

The frequency and intensity of prevailing westerly winds in this region influence the distribution and composition of resident plant communities (Moss 1944). Ridgetops and windswept western exposures are occupied by an open, Limber Pine (*Pinus flexilis*)–Douglas Fir (*Pseudotsuga menziesii* var. *glauca*) woodland (windward community). More protected north- and east-facing slopes are dominated by stands of Douglas Fir (leeward pure community) with occasional hybrid spruce (*Picea glauca* × *P. engelmannii*; see Daubenmire 1974). The gentler leeward slopes at the base of the ridge that comprised the Zoratti area are inhabited by mixed stands of Limber Pine and Douglas Fir (leeward mixed community) which appear to be seral to the adjacent leeward pure community.

The coniferous communities were sampled in 20 × 20 m plots, but the sampling intensity differed on the two study areas. Approximately 10% of the Zoratti site was examined with 38 plots whose centers were 45 m apart along transects at 100-m intervals. The Skelton area was too large to be sampled this intensively and 40 plots were chosen from an original 190, distributed as on the Zoratti area, on the basis of community type, tree density, and the uniformity of tree distribution. Several plots that did not include more than 20 trees were enlarged to cover an area of 500 m^2.

Species, circumference at breast height, height, and evidence and the probable cause of any leader damage were determined for all trees taller than breast height (1.35 m) within each sample plot. A random selection of 20% of these trees was aged with an increment borer. Each tree was inspected for feeding scars and a record made of the intensity of use (four classes based on total scar area) for the tree as a whole and separately for lateral branches and the bole. The number of years since feeding occurred, the height range, and the intensity of use for each year of feeding were estimated. I determined year of feeding by removing a portion of the scar tissue surrounding the feeding area and counting the annual rings from the level of exposure by the Porcupine to the current xylem surface.

Limber Pine and Douglas Fir are considered excellent dendrochronological material because of a high correlation between ring formation and the annual climatic cycle (Schulman 1956). The age of very old scars on senescent branches at the base of the crown, however, was probably measured less accurately than the age of the tree because these old branches produce xylem rings irregularly (Reukema 1959).

Several characteristics were calculated for each tree. Diameter at breast height (DBH) was derived from the circumference. The ratio of DBH to height served as an index of growth form based on the direct relation between bole diameter and crown width (Mitchell 1969). The magnitude of this confirmation index (CI) generally ranged from 0.75 to 3.00 and was useful only for intraspecific comparisons because growth form varies between species. Estimates of the average annual growth of the bole and height of the tree were calculated by dividing DBH and height, respectively, by age.

Because current DBH is only indirectly related to the dimensions of trees considered by Porcupines during previous years, I estimated the DBH and height of each tree for the preceding 20 yr. Annual growth increments ($\pm 5 \times 10^{-4}$ mm) for each of the past 20 yr were measured for each core with a dissecting microscope. The length of each increment core, from the pith to its outer surface, and the thickness of the bark (±0.025 mm) extracted at breast height with the increment borer, were measured with vernier calipers.

Calculation of DBH, x yr prior to measurement, employed the following basic algorithm. The radius inside the bark during the year of interest (IR_x) was taken as the product of the inside radius at the time of measurement ((DBH/2)–BARK) and the proportion of the total length (TC) represented by the length of the core x yr previous ($TC-\sum_{n=1}^{x} I_n$; where I_n is the length of the growth increment for any given year, n. Therefore,

$$IR_x = ((DBH/2)\text{–}BARK) \cdot ((TC-\sum_{n=1}^{x} I_n)/TC),$$

and the DBH during that year was estimated with the linear regression equation that related the inside radius at the time of measurement to the measured DBH for a particular species in a given community (Husch et al. 1972). The error associated with this regression equation is probably negligible since the smallest coefficient of determination (r^2) was 0.997. Regression equations that described the relation between the calculated DBH and the age and measured DBH were computed for each of the 20 yr preceding measurement from the data for cored trees from each forest type and were used to estimate past diameters for uncored trees.

The procedure applied in estimating the height of a tree during each of the 20 yr prior to measurement, took advantage of the relation between height and DBH. The growth of a tree was taken as a straight line, on a log-log plot, between the measured height and DBH and a height of 1.35 m and zero DBH, which allowed the estimation of the height corresponding to any previously established DBH. If primary growth had been interrupted by a factor other than that of a Porcupine killing the leader, or if the tree was girdled more than 20 yr before measurement, previous heights were not calculated. If the leader was killed by Porcupines within 20 yr of measurement, the height during any year since the feeding occurred was estimated from a regression line between the measured height and DBH, and the height of the uppermost feeding scar and the calculated DBH for the year during which feeding occurred.

With the exception of leeward pure forests, only a small proportion of the available trees was used by Porcupines during a given year and the average position of each tree in relation to the community mean during the 20 yr prior to measurement, has been examined rather than the tree's absolute size or age. Data for DBH, height, and CI were normalized ($[X_i-\bar{X}]/s$; Sokal and Rohlf 1969) for each of the 20 yr prior to measurement. The average transformation of each of the three variables for each tree during this period, therefore, becomes an indicator of its relative status in the community, measured in standard deviations from the mean of zero.

Results

Preferences for Individual Trees

Porcupines fed on 37.1% (368) of the 993 Douglas Fir and Limber Pine sampled on the Zoratti area. Only 17.8% (78/439) of the conifers in the windward community were used by Porcupines, while 24.4% (40/164) of the trees in the leeward mixed community and 64.1% (250/390) of the trees in the leeward pure community were used. A significantly smaller pro-

TABLE 1—Comparisons of the ages, relative sizes, and estimated annual growth increments of trees fed upon by Porcupines with unused trees on the Zoratti and Skelton areas. Limber Pine in the Skelton windward community were not compared because only two trees were used during the 20 yr preceding measurement. Means ± SE (n) are given. Species/location code: first character Z—Zoratti or S—Skelton; second character W—windward, P—leeward pure, or M—leeward mixed; third character F—Douglas Fir or P—Limber Pine

Species, location	Age (yr)		DBH		Height		CI		DBH growth (cm/yr)		Height growth (m/yr)	
	Used	Unused	Used	Unused	Used	Unused	Used	Unused	Used	Unused	Used	Unused
ZWF	60.2 ±11.55 (9)	59.1 ±4.96 (17)	0.57* ±0.403 (10)	−0.28 ±0.119 (57)	0.30 ±0.368 (10)	−0.21 ±0.129 (56)	0.58 ±0.475 (10)	−0.34 ±0.120 (56)	0.18 ±0.048 (9)	0.14 ±0.019 (17)	0.08 ±0.018 (8)	0.07 ±0.005 (17)
ZPF	60.8 ±2.09 (70)	58.3 ±3.51 (44)	0.19*** ±0.070 (205)	−0.37 ±0.074 (176)	0.14*** ±0.069 (182)	−0.30 ±0.088 (159)	0.25*** ±0.074 (182)	−0.45 ±0.076 (159)	0.29** ±0.015 (70)	0.22 ±0.018 (44)	0.17 ±0.008 (52)	0.15 ±0.009 (43)
ZMF	62.6*** ±3.51 (12)	33.9 ±4.13 (16)	1.08*** ±0.315 (9)	−0.42 ±0.107 (59)	1.00*** ±0.311 (9)	−0.38 ±0.113 (58)	0.70** ±0.239 (9)	−0.43 ±0.131 (58)	0.34** ±0.030 (12)	0.19 ±0.031 (16)	0.15 ±0.016 (10)	0.13 ±0.012 (15)
ZWP	73.2 ±8.08 (31)	66.5 ±1.72 (81)	0.32 ±0.217 (47)	−0.08 ±0.050 (325)	0.31 ±0.183 (45)	−0.08 ±0.058 (266)	0.18 ±0.179 (45)	−0.08 ±0.060 (266)	0.15* ±0.013 (31)	0.12 ±0.006 (81)	0.05 ±0.004 (21)	0.04 ±0.002 (74)
ZMP	62.4* ±7.30 (7)	44.1 ±3.65 (23)	0.88*** ±0.254 (11)	−0.27 ±0.107 (85)	0.62* ±0.210 (10)	−0.25 ±0.125 (69)	0.93*** ±0.316 (10)	−0.33 ±0.177 (69)	0.29 ±0.035 (7)	0.21 ±0.023 (23)	0.10 ±0.013 (5)	0.11 ±0.007 (20)
SWF	91.0** ±6.77 (9)	70.8 ±2.41 (45)	0.91*** ±0.253 (18)	−0.07 ±0.063 (236)	0.77** ±0.214 (18)	−0.07 ±0.066 (220)	0.35 ±0.193 (18)	−0.03 ±0.068 (220)	0.30 ±0.056 (9)	0.21 ±0.014 (45)	0.12 ±0.022 (7)	0.09 ±0.006 (42)
SPF	72.5*** ±1.88 (45)	63.8 ±1.21 (189)	0.83*** ±0.079 (163)	−0.18 ±0.029 (1058)	0.34*** ±0.089 (151)	−0.11 ±0.033 (977)	0.97*** ±0.091 (151)	−0.21 ±0.029 (977)	0.33*** ±0.019 (45)	0.26 ±0.007 (189)	0.20** ±0.011 (25)	0.17 ±0.004 (184)

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

portion (22.4%: log likelihood ratio, $P < 0.005$) of the 1601 conifers sampled on the Skelton area were fed upon by Porcupines; windward trees there were also used less frequently (12.3%, 45/367) than trees in the adjacent leeward pure community (25.4%, 313/1234).

During the 20 yr preceding measurement, Porcupines usually fed in trees that were significantly larger and had more extensive crowns than the trees they neglected, even though the selected trees were not necessarily statistically older than unused trees (Table 1). In addition, Douglas Fir fed upon by Porcupines in the preferred leeward pure communities grew significantly faster, at least in bole diameter, than unused trees (Table 1). Porcupines on the Zoratti area also used Douglas Fir in the leeward mixed community, and Limber Pine in the windward community that grew faster in bole diameter than the trees they neglected. Stepwise discriminant analyses (Table 2) indicate that DBH and growth form are more effective characteristics for distinguishing used

TABLE 2—Discriminant analysis statistics detailing variables that best distinguished between trees fed upon by Porcupines and unused trees on the Zoratti and Skelton areas[1]

Species, location[2]	Independent variable[3]	Constant	Discriminant coefficient	Wilks' lambda
ZWF	CI (56,10)	0.194	0.952	0.900**
ZPF	CI (159,182)	0.077	0.968	0.887***
ZMF	DBH (58,9)	0.212	1.023	0.728***
ZWP	DBH (266,45)	0.026	0.959	0.976**
ZMP	CI (69,10)	0.164	0.944	0.841***
SWF	DBH (220,18)	−0.004	1.018	0.931***
SPF	CI (997,151)	0.051	0.971	0.847***

[1]Discriminant analyses were first performed on aged trees only, but because age was not an effective discriminator the analyses presented are based on all trees.
[2]Species/location code given in Table 1.
[3]Quantities in parentheses represent the number of unused and used trees during the 20-yr period preceding measurement.
**$P < 0.01$.
***$P < 0.001$.

TABLE 3—Mean ± SE (n) estimated size of Douglas Fir in leeward pure communities during 1955 and 1970, and of trees fed upon by Porcupines, 1954–1973

	1955	1970	Used
Zoratti area			
DBH (cm)	11.6 ± 0.38 (343)	16.3 ± 0.50 (381)	16.9 ± 0.55 (256)
Height (m)	7.6 ± 0.18 (313)	9.2 ± 0.22 (341)	9.1 ± 0.22 (232)
CI	1.41 ± 0.033 (309)	1.70 ± 0.034 (341)	1.81 ± 0.045 (232)
Skelton area			
DBH (cm)	17.1 ± 0.26 (1134)	19.4 ± 0.30 (1211)	26.0 ± 0.73 (195)
Height (m)	10.8 ± 0.11 (1050)	11.6 ± 0.13 (1127)	12.0 ± 0.35 (179)
CI	1.55 ± 0.017 (1041)	1.62 ± 0.017 (1117)	2.22 ± 0.054 (179)

trees from unused trees than age or height. Any tendency for used trees to be older or taller was probably an artifact of the strong intercorrelations between all four variables.

Only in the leeward pure forests were trees fed upon with sufficient frequency to allow an examination of the absolute size of used trees. Trees used during the 20 yr prior to measurement in the Skelton leeward forest were significantly larger than those used on the Zoratti area (t-test, DBH $P < 0.001$; height $P < 0.001$; CI $P < 0.001$). Although trees on the Skelton area were generally larger than those on the Zoratti area (Table 3), this difference is not sufficient to explain the disparity in the size of trees used.

Location and Amount of Feeding within Trees

Although Porcupines feed on both the inner bark and foliage of conifers, evidence of feeding on foliage is ephemeral and cannot be assessed after several years. Porcupines tend to feed in the upper portions of conifers on the bole and lateral branches (Tables 4, 5; Gabrielson 1928; Taylor 1935; Shapiro 1949). Feeding scars on the upper surfaces of branches were usually encountered over a greater height range within a particular tree than were scars on the bole.

Usually less than 650 cm^2 of bark were removed from an individual tree per winter, although many trees were used more extensively (Table 6). Feeding most commonly occurred on portions of the tree unprotected by corky bark, such as the distal ends of branches and the upper bole. Porcupines often succeeded in removing bark from the entire circumference of the bole. This caused the death of the upper crown and often altered the tree's form, particularly if the tree was girdled again in subsequent years (Table 7).

Discussion

A preference by Porcupines for relatively large fast-growing trees has been widely reported (Rudolf 1949; Curtis and Wilson 1953; Krefting et al. 1962; Spencer 1964) and was also evident on the Zoratti and Skelton areas in this study. Vigorous trees with large open crowns produce a larger annual increment of phloem

TABLE 4—Mean ± SD (n) position of Porcupine feeding within trees on the Zoratti and Skelton areas. Except for the column on the extreme right, position is measured on a scale on which ground level has a value of 0 and the top of the tree has a value of 1. Position of the mode within the feeding range involved a similar scale on which the bottom and top of the feeding range within a tree had values of 0 and 1, respectively

Species, location[1]	Top of feeding range	Bottom of feeding range	Mode of feeding within tree	Mode of feeding within feeding range
ZWF	0.51 ± 0.204 (11)	0.29 ± 0.212 (11)	0.38 ± 0.207 (9)	0.62 ± 0.243 (9)
ZPF	0.80 ± 0.200 (233)	0.37 ± 0.203 (233)	0.65 ± 0.190 (121)	0.59 ± 0.181 (165)
ZMF	0.58 ± 0.275 (244)	0.24 ± 0.170 (24)	0.40 ± 0.214 (16)	0.60 ± 0.164 (13)
ZWP	0.63 ± 0.275 (49)	0.33 ± 0.242 (49)	0.51 ± 0.237 (40)	0.57 ± 0.242 (40)
ZMP	0.66 ± 0.249 (16)	0.42 ± 0.199 (16)	0.57 ± 0.109 (7)	0.53 ± 0.182 (12)
SWF	0.78 ± 0.176 (19)	0.37 ± 0.199 (19)	0.67 ± 0.171 (10)	0.72 ± 0.171 (19)
SPF	0.82 ± 0.197 (179)	0.49 ± 0.222 (179)	0.66 ± 0.180 (78)	0.59 ± 0.244 (182)
SWP	— (2)	— (2)	— (2)	0.67 ± 0.313 (6)

[1]Species/location code given in Table 1.

TABLE 5—Relative frequency of feeding on boles and branches by Porcupines. These data are from trees that were used during a single year only

Species, location[1]	Branch use greater	Equal	Bole use greater
ZWF	5	0	5
ZPF	96	5	116
ZMF	12	2	7
ZWP	19	1	38
ZMP	3	1	13
SWF	25	3	8
SPF	208	5	77
SWP	1	0	3

[1]Species/location code given in Table 1.

TABLE 6—Number of trees and area of bark removed by Porcupines per year of feeding

Species, location[1]	Area (cm^2)			
	< 650	650–1900	1900–3200	> 3200
ZWF	12	0	0	0
ZPF	157	132	8	2
ZMF	16	11	0	0
ZWP	52	16	3	0
ZMP	15	7	1	0
SWF	38	4	0	0
SPF	300	85	9	2
SWP	6	2	0	0

[1]Species/location code given in Table 1.

TABLE 7—Frequency of girdling of conifers by Porcupines on the Skelton area

Species, location[1]	Frequency of leader death			
	0	1	2	3
SWF	29	8	0	0
SPF	172	105	30	4
SWP	6	3	0	0

[1]Species/location code given in Table 1.

(Bannan 1955; Grillos and Smith 1959), and provide more foliage and a greater volume of inner bark than crowded trees. Because Porcupines generally feed on inner bark that is accessible from positions that can be maintained without undue exertion (Taylor 1935; Spencer 1964), open-crowned trees, which provide more large branches, allow Porcupines greater access to food. The phloem and foliage of conifers contain the greatest concentrations of fats and carbohydrates of the aerial tissues (see Kramer and Kozlowski (1960) for a review), and the tendency of Porcupines to feed on these structures within the tree crown where growth is most rapid may result in the consumption of the most nutritious food available.

The quality of a food item is a complex property that involves not only its energy and nutrient content, but also the digestion and assimilation efficiency of its consumers (Longhurst et al. 1968), and the influence of secondary plant compounds (Freeland and Janzen 1974). In addition, an animal's response to a particular stimulus, such as food with a specific nutrient content, can be greatly modified by its physiological state (Cabanac 1971). An awareness by Porcupines of chemical qualities is not required to explain the observed preferences for particular trees, because vigorous trees may be identified by obvious physical features. Chemical attributes, however, may be important within trees because Porcupines appear to select food items through olfaction (Murie 1926; Taylor 1935).

The average diameters of used trees from both study areas (Table 3) fall within the range of size preferences reported for Porcupines from various regions of North America (Taylor 1935; Curtis and Wilson 1953; Krefting et al. 1962; van Deusen and Myers 1962). A predilection for a particular size class irrespective of geographic location or tree species lends support to the suggestion of Curtis and Wilson (1953) that Porcupines may be most adept at climbing trees with a DBH between 15 and 25 cm. Presumably trees can become too large to be readily climbed (Taylor 1935; Curtis and Kozicky 1944; Curtis and Wilson 1953), resulting in a decline in their use by Porcupines even though they may contain large quantities of high-quality food. Local differences in the size of used trees of the magnitude observed between the Zoratti and Skelton areas would not be expected, however, if Porcupines exercised size preferences solely related to the ease of climbing trees, unless the preferred size was unavailable. Storm and Halvorson (1967) have presented convincing evidence that the removal of bark by Porcupines greatly affects the vigor of a tree for up to 10 yr. If a forest, such as the leeward pure community on the Zoratti area, was heavily used for several years, the number of rapidly growing trees within the preferred size class would be reduced. Porcupines feeding in this forest during subsequent winters could, therefore, face a choice between slower-growing trees of the appropriate size or smaller vigorous trees.

Consumers cannot afford to be selective when resources are limited (Emlen 1966, 1968). Relaxation of selectivity may have occurred on the more extensively used Zoratti area and resulted in the apparent preference for smaller trees. The trees used

on the Skelton area consequently may provide a better indication of the physical qualities of trees preferred by Porcupines.

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Interactions between Snowy and Short-eared Owls in Winter

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Observations on habitat use, food habits, and behavioral interactions of Snowy Owls (*Nyctea scandiaca*) and Short-eared Owls (*Asio flammeus*) in winter near Calgary, Alberta, suggest that no serious competition occurs between them. They differ in habitat use, obtaining different types of prey as a result. Kleptoparasitism by Snowy Owls upon Short-eared Owls may be the most frequent interspecific interaction. Reports of Short-eared Owls in the diet of Snowy Owls probably reflect opportunistic feeding, rather than a mechanism to reduce competition for food.

Key Words: Snowy Owl, *Nyctea scandiaca*, Short-eared Owl, *Asio flammeus*, habitat use, food habits, kleptoparasitism, Alberta, winter.

Levin et al. (1977) described a case of probable predation by the Snowy Owl (*Nyctea scandiaca*) upon the smaller Short-eared Owl (*Asio flammeus*), and considered the complex relationship between two possible competitors that may also interact as predator and prey. They suggest that, besides obtaining food, the larger raptor may benefit by eliminating a potential competitor. We report findings that clarify the interactions between these species in winter.

Our observations were made near Calgary, Alberta (51° N, 114° W), where Snowy Owls regularly winter (Bird 1972). Short-eared Owls breed near Calgary, and some overwinter in certain years (Salt and Salt 1976). Hence the two species sometimes come into contact, providing opportunities to witness interactions.

Methods

Our study area is a 185-km^2 block of agricultural land southeast of Calgary. Approximately 70% of the area is cultivated for cereal grains, and about 20% is hayfields and pasture. Numerous small sloughs contain water in spring but support a dense cover of grasses, sedges, and weeds during the rest of the year.

During visits to the area we recorded the habitat in which each owl was located when first sighted. If an owl was on a boundary between two habitats a value of 0.5 owl was assigned to each.

We analyzed pellets obtained at known roosting sites and around hunting perches. Most pellets were readily assigned to one or the other species by differences in size and by association with known perches. The identity of a few pellets was questionable; these were omitted from the analysis. Fragmented remnants of an estimated four to six pellets from a Short-eared Owl roost were also analyzed.

Observations of interspecific interactions were made whenever possible from 1973 through 1978. Between November 1977 and March 1978 over 130 h of behavioral observations of Snowy Owls were made.

Results

The habitat distributions of sightings of the two species (Table 1) are not totally comparable because of behavioral differences. Many of the Snowy Owl

Table 1—Habitat distributions of Snowy and Short-eared Owl sightings on the study area in the winter of 1977–1978, plus the habitat distribution of prey-capture attempts by Snowy Owls

Habitat	Number of cases (% total)		
	Snowy Owl sightings	Short-eared Owl sightings	Snowy Owl hunting attempts
Stubblefield	87.5 (43.8)	30.5 (51.7)	14.5 (51.7)
Summerfallow	60.0 (30.0)	1.5 (2.5)	0.5 (1.8)
Hayfield	28.5 (14.3)	7.0 (11.9)	7.0 (25.0)
Pasture	14.0 (7.0)	1.5 (2.5)	1.0 (3.6)
Ungrazed grassland	6.0 (3.0)	1.0 (1.7)	1.5 (5.4)
Slough	4.0 (2.0)	17.5 (29.7)	3.5 (12.5)
Total	200.0 (100.1)	59.0 (100.0)	28 (100.0)

sightings probably were of non-hunting birds, because they roost in conspicuous locations such as on poles or hilltops. Short-eared Owls use communal roosts in winter, in locations offering protection from both weather and easy detection (Clark 1975; personal observation). Therefore, most Short-eared Owls seen were flying and probably were hunting. The distribution of prey-capture attempts by Snowy Owls (Table 1) is also not fully comparable with the Short-eared Owl sightings because we cannot assume that all the Short-ears were hunting.

Both species were observed most often in stubblefields, which comprised 37% of the study area. While most hunts by Snowy Owls were also in this habitat (Table 1), many of the Short-eared Owls recorded in stubble actually appeared to be hunting over road ditches or sloughs and were assigned to stubble only because they were crossing that habitat when first sighted. Data on prey-capture attempts by Short-eared Owls are unavailable, but would probably indicate a lesser importance of this habitat than it has for Snowy Owls.

The high number of Snowy Owls sighted in summerfallow relates to their roosting habits, described above. They rarely hunted in this habitat (Table 1). Sloughs, comprising only 3.6% of the study area, are favored hunting locations for Short-eared Owls, which frequently are seen coursing back and forth over them. In contrast, few hunting attempts by Snowy Owls were observed around sloughs (Table 1).

Table 2 lists the prey items recovered from pellets. The proportions of Deer Mice (*Peromyscus maniculatus*) and Meadow Voles (*Microtus pennsylvanicus*) in the diets of the two species differ significantly (chi-square test, $P < 0.001$). *Microtus* comprised 79% of prey individuals in Short-eared Owl pellets but were only half as frequent as *Peromyscus* in Snowy Owl pellets.

Remains (feet and skull fragments) of Short-eared Owls were recovered from two Snowy Owl pellets found on Snowy Owl territories adjacent to Short-eared Owl roosts. The range of prey size is greater for the Snowy Owl, as expected from its larger body size (Schoener 1969).

Although both Snowy and Short-eared Owls were seen repeatedly in the same areas, only a few actual encounters were witnessed. These are summarized as follows:

1) 18 February 1975. At 15:57 (MST) a Snowy Owl (SO) flew from a power pole toward a Short-eared Owl (SEO) hunting 300–400 m away. As it approached, the SEO dove at it, coming within 2–3 m. The SO landed and assumed a crouched defensive posture with the body axis at 15–20° from the horizontal, plumage ruffled, and wings partly spread. The SEO circled, making repeated shallow stoops, for 2–3 min before flying away.

TABLE 2—Prey of Snowy Owls and Short-eared Owls on the study area in the winter of 1977–1978, as determined from examination of pellets

Prey species	Number of individuals (% total)	
	Snowy Owl[1]	Short-eared Owl[2]
Mammals		
Peromyscus maniculatus	79 (51.0)	8 (16.7)
Microtus pennsylvanicus	39 (25.3)	38 (79.2)
Spermophilus richardsoni[3]	12 (7.7)	0
Mustela frenata[4]	3 (1.9)	0
Birds		
Perdix perdix[5]	14 (9.0)	0
Asio flammeus	2 (1.3)	—
Passerine spp.	6 (3.9)	2 (4.2)
Total	155 (100.1)	48 (100.1)

[1]Based on analysis of 72 pellets.
[2]Based on analysis of 22 pellets plus numerous fragments.
[3]Richardson's Ground Squirrel.
[4]Long-tailed Weasel.
[5]Gray Partridge.

2) 1 December 1977. A SO was perched on a powerline tower in a pasture. At 16:07 a SEO, flying high above, dove at it, coming within 2 m. It circled about 10 m above the SO, then stooped again. There was no observable response. The SEO then flew off and began hunting in a field 800 m away.

3) 6 December 1977. At 13:45, a hunting SEO landed in a stubblefield 200 m from a perched SO. The SO flew and supplanted the SEO, which then circled 8–10 m above it, uttering "keeow" calls for 20–30 s before flying away. The SO was not disturbed by this, but appeared to be watching another SO flying in the distance.

4) 14 December 1977. A SO was perched on a knoll in a stubblefield. At 13:32 a SEO flew towards it and stooped several times within 1 m of the perched SO, which ducked while watching its attacker. The SEO circled several times, then flew to a fencepost 900 m away. It resumed hunting at 13:41.

5) 21 December 1977. At 15:00 a SO flew to a power pole near a SEO that was hunting in a stubblefield. As the SO landed, the SEO flew toward it and dove twice, coming within 3 m. Three other SEOs immediately joined the first and circled 25–30 m above the SO. After 1 min the SEOs scattered and resumed hunting. No reactions by the SO were seen.

6) 21 December 1977. A SO was sitting on the ground 100 m from a slough where a SEO was hunting. Between 17:25 and 17:30 the SEO made three unsuccessful pounces at prey, without landing for longer than 10 s. The SO watched the SEO but did not appear aroused. At 17:30 the SEO landed in the grass, whereupon the SO flew and supplanted it. The SEO took flight, circled briefly 10–15 m above the SO, and flew away. The SO then flew back and forth across

the slough several times and landed on a fencepost about 150 m away.

7) 19 December 1978. At 15:00 a SO flew from a power pole toward a SEO flying, with a mouse in its feet, about 500 m away. As the SO approached, both owls disappeared behind a low rise. Almost immediately the SEO rose straight up to about 15 m with empty feet. It circled the area, stooping toward the ground several times, before flying away. The SO, which presumably was perched on the ground with the mouse, was not re-sighted.

Discussion

The interspecific differences in habitat use and diet are closely interrelated. Snap-trapping surveys at the beginning of the winter of 1977–1978 indicated that *Microtus* were most common in sloughs and roadside ditches (Boxall, unpublished data), where Short-eared Owls frequently were observed hunting. The preference of *Microtus* for dense cover is well-known (e.g., Birney et al. 1976). *Peromyscus* were more abundant than *Microtus* in stubblefields and hayfields, where most Snowy Owl hunting attempts were observed (Table 1).

The failure of Snowy Owls to prey more heavily on *Microtus* may be related to hunting behavior. Snowy Owls are "sit and wait" predators, launching hunting attempts from perches after prey has been detected (Höhn 1973; personal observation). In contrast, Short-eared Owls hunt primarily by flying back and forth low over vegetation (Clark 1975), pouncing on any prey located. A small mammal moving within the dense cover in sloughs or ditches would be screened from a Snowy Owl perched some distance away, but would be visible to a flying Short-eared Owl looking directly down into the vegetation.

The data on habitat use and food habits suggest that considerable ecological segregation exists between the two species and that interspecific competition for food is unlikely under the conditions of our study. Our behavioral observations support this conclusion. Snowy Owls initiated four interactions. Two (see examples 3 and 6) were in apparent response to a Short-eared Owl landing after prey-capture attempts that might have been successful. In observation 6 the Snowy Owl did not react to the Short-ear hunting nearby until, after 5 min, the latter landed for longer than a few seconds. We suggest that these actions by Snowy Owls were attempted piracy, triggered by an apparently successful hunt by a Short-eared Owl. Observation 7 appears to be a definite example of kleptoparasitism. Duffy et al. (1976) describe kleptoparasitism by a Snowy Owl on a Marsh Hawk (*Circus cyaneus*) and Tullock (1968) reported Snowy Owls robbing Hooded Crows (*Corvus corone*).

Snowy Owls supplanted Short-eared Owls in several cases but did not pursue them. These probably were not attempts at predation because Snowy Owls will pursue flying prey (Meinertzhagen 1959; Nero 1964). Similarly, interspecific territoriality is an unlikely explanation for such encounters because Snowy Owls ignored Short-eared Owls unless the latter appeared to have captured prey. Snowy Owls are territorial in winter (Keith 1964), but the postures and modified flight patterns seen in intraspecific territorial encounters (personal observation) were absent in these interspecific interactions.

The encounters initiated by Short-eared Owls (see examples 2, 4, 5), and the reaction of the Short-eared Owls in observations 1 and 7, are examples of the mobbing response of many birds to predators (Hinde 1970). Once mobbing by one Short-eared Owl attracted three conspecifics to join in briefly. The "keeow" vocalization noted in observation 3 is an alarm call of the Short-eared Owl (Clark 1975). The displays used by Short-eared Owls in intraspecific territorial encounters (Lockie 1955; Clark 1975) were not seen. Breeding Short-eared Owls direct such displays towards various raptors (Clark 1975), and we have seen a wintering Short-ear display to a Rough-legged Hawk (*Buteo lagopus*). Thus the behavior of Short-eared Owls towards Snowy Owls is an alarm response rather than an aggressive or territorial one. The posture of the Snowy Owl while being mobbed in observation 1 resembles that of owls attacked by jaegers (*Stercorarius* spp.) (Tullock 1968) or by a Goshawk (*Accipiter gentilis*) (personal observation).

The lack of territoriality between Snowy Owls and Short-eared Owls in winter, along with differences in habitat use and diet, suggests little competition between them. Short-eared Owls winter in areas with high populations of small mammals (Clark 1975), suggesting that winter contact with Snowy Owls will occur primarily in situations where high food density alleviates competition (see also Lack 1946). Pitelka et al. (1955) recorded no interactions between these two species at Barrow, Alaska, when they bred together in response to a high lemming population.

We suggest that the major relationship between the two species is that of kleptoparasite and victim. The mobbing reactions of the Short-eared Owls demonstrate that they recognize Snowy Owls as potential pirates or predators. In most records of Short-eared Owls in the diet of Snowy Owls (e.g., Uttendorfer 1952; Mikkola 1976) it is unknown whether predation or scavenging had occurred. The Snowy Owl has remarkably catholic food habits (Gross 1944) and actual predation may be of irregular or exceptional occurrence. The rarity of documented predation and the weakness of the Short-eared Owl's mobbing reaction suggest that Snowy Owl predation upon Short-eared Owls is not significant in the biology of either species.

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The Biological Flora of Canada

1. *Vaccinium angustifolium* Ait., Sweet Lowbush Blueberry*

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This contribution on *Vaccinium angustifolium* Ait., Sweet Lowbush Blueberry (Ericaceae), is the first of a series presenting biological information on plants that are components of the flora of Canada. *Vaccinium angustifolium* is a deciduous low shrub endemic to North America, whose range in Canada extends from the east coast of Newfoundland to Lake Winnipeg in Manitoba. It occurs from Quebec 57°N to Virginia 38°N. To produce fruit the flowers usually require cross-pollination by wild bees or related insects. The fruit of *V. angustifolium* is edible and matures during late summer. During the past 30 yr in the Atlantic Provinces of Canada many fields abandoned from other forms of agriculture have been brought into stands of this species by burn-pruning and selective weed control.

Key Words: *Vaccinium angustifolium,* Sweet Lowbush Blueberry, biology, ecology, physiology, distribution, economic importance.

1. *Name*

Vaccinium angustifolium Ait.; section *Cyanococcus;* Ericaceae;
V. lamarckii Camp (Camp 1943, 1945);
V. pennsylvanicum Lam. (Robinson and Fernald 1908);
V. pensilvanicum Lam. (Fernald 1950); Sweet Lowbush Blueberry;
airelle à feuilles étroites (Marie-Victorin 1964).

2. *Description of the Mature Plant*

(*a*) *Raunkiaer life-form.* Chamaephyte. Winter-deciduous, broad-leaved low shrub with ascending branches, edible blue fruits, deep tap root; reproduces by seeds and rhizomes.

(*b*) *Shoot morphology.* Stems woody, average height 20 cm with maximum of 50 cm, generally glabrous, with raised lenticels, the bark variously pigmented from yellow to deep red in autumn; buds of two types, the larger flower buds borne terminally, the more lanceolate vegetative buds born proximally; leaves alternate in a spiral, simple, pinnately netted, serrate glandular, elliptic or ovate-oblong, apex acute, base obtuse, the ventral surface waxy green, the dorsal surface pale green and sometimes with light bloom; rhizomes woody bearing numerous shoots, new growth white or pinkish (Figure 1a, b).

(*c*) *Root morphology.* The radicle of the seedling develops into an extensive tap root system (Hall 1957); the root system is finely divided at the extremities and several authors state that there are no root hairs (e.g., Addoms and Mounce 1931).

(*d*) *Inflorescence.* The members of *Vaccinium* section *Cyanococcus* are characterized by flowers borne in racemes; members of section *Vaccinium* by contrast have flowers borne singly in the leaf axils. Flowers of *V. angustifolium* are typically pentacyclic with five sepals, five petals fused into a bell-shaped corolla, 10 stamens in two whorls of five and fused to the corolla, and a single pistil with inferior ovary. Fruit is a true berry bearing 10 pseudolocules each with a few to many small seeds. Bell (1957) found that the average number of perfect seeds was 13 and of imperfect seeds was 50 per berry. Some mutants were reported by Hall, Aalders, and Lockhart (1964). Both *Vaccinium* and *Gaylussacia* have inferior ovaries but the seeds of the former are much smaller.

(*e*) *Subspecies.* None.

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*See La Roi (1977) for notice, guidelines and schedule for contributors.

FIGURE 1. Sweet Lowbush Blueberry Plant. A: Above, close-up of flowers; below, flowering plant. B: Above, close-up of fruit; below, fruiting plant.

(*f*) *Varieties and forms.* Fernald (1950) recognized a puberulent var. *hypolasium* and a smooth-leaved var. *laevifolium* House, but we do not, considering these to be part of the variation found in the species. We recognize the following forms: *V. angustifolium* Ait. forma *angustifolium* with green leaves, fruit with a heavy bloom, consequently a blue color, and straight stems, is the most frequent taxon (Vander Kloet 1978); *V. angustifolium* forma *nigrum* (Wood) Boivin is characterized by blue-green leaves, fruit with little or no bloom giving it a black color, and zigzag stems (Aalders and Hall 1963a); *V. angustifolium* forma *leucocarpum* (Deane) Rehder is a white-fruited form.

(*g*) *Ecotypes.* Forma *nigrum* tends to increase more rapidly than forma *angustifolium* in stands that are burned regularly (Hall et al. 1975).

(*h*) *Chromosome numbers.* Longley (1927) first reported 24 bivalent chromosomes for *V. angustifolium.* Newcomer (1941) *sub V. pennsylvanicum* also reported that five selections had $n = 24$ chromosomes. Darrow et al. (1942) are the only workers to report a diploid condition ($2n = 24$) but no voucher specimen for this count can be located (Vander Kloet 1978). Counts from clones of Canadian and Maine *V. angustifolium* all have $2n = 48$ (Hall and Aalders 1961; Bent and Vander Kloet 1976; Hersey and Vander Kloet 1976; Whitton 1964).

3. *Distribution and Abundance*

(*a*) *Geographic range. Vaccinium angustifolium* is a North American endemic, extending from Cape St. Francis on the eastern tip of Newfoundland to the Pine Falls area of Lake Winnipeg in south central Manitoba (Figure 2). It extends from 57°N in northern Quebec southward to isolated uplands in the Appalachian Mountains of Virginia, 38°N. A complete distribution map appears in Vander Kloet (1978).

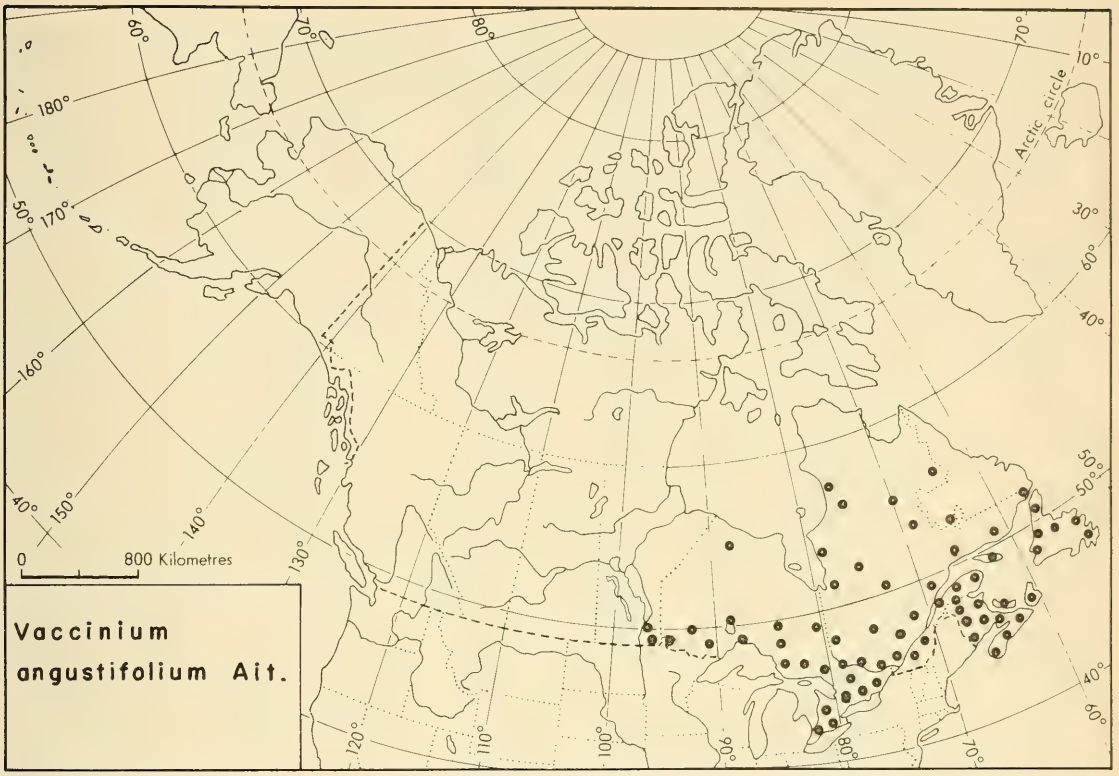

FIGURE 2. Canadian distribution of *Vaccinium angustifolium* from specimens in the Department of Agriculture Herbarium, Ottawa, Ontario (DAO); National Herbarium, National Museums of Canada, Ottawa, Ontario (CAN); and Acadia University Herbarium, Wolfville, Nova Scotia (ACAD).

(*b*) *Altitudinal range. Vaccinium angustifolium* extends from ca. sea level to 1300 m asl in Eastern Canada to 1300–1500 m asl in Virginia. On the higher points of the Adirondack Mountains *V. angustifolium* is replaced by *V. boreale* (Sweet Hurts) (Vander Kloet 1977).

4. *Physical Habitat*

(*a*) *Climatic relations. Vaccinium angustifolium* occurs in a large area of eastern North America and tolerates a wide range of climatic conditions. The variability of this species with regard to productivity is well established (Aalders and Hall 1963b; Hall, Aalders, and Wood 1966) but the adaptiveness of the species to different climatic conditions requires further study. A comparison of growth under different climatic conditions was conducted on uniform plant and soil media in 1965 and 1966 at Kentville, Nova Scotia; Normandin, Quebec; and St. John's West, Newfoundland. Linear shoot growth of 20 plants from seven clones at the three respective stations averaged 183, 141, and 111 cm per plant in 1965; and 195, 153, and 70 cm in 1966. The number of flower buds produced per plant averaged 126, 94, and 66 in 1965; and 88, 54, and 23 in 1966. Thus climatic conditions for growth varied widely among the three stations. Vegetative growth was not notably different between 1965 and 1966 at Kentville and Normandin, but much poorer in 1966 at St. John's West; reproductive growth was much better in 1965 than 1966 at all three stations.

In Eastern Canada, winter temperatures for *V. angustifolium* and other chamaephytes are generally ameliorated by a snow cover. Inadequate snow cover may be followed by shoot dieback to ground level in the Lac de St. Jean area (Poirier and Dubé 1969). Unusually warm weather and salt spray from a February hurricane, followed by cold temperatures, were probably responsible for extensive mortality of *V. angustifolium* flower buds (Figure 3) in the Fox River area of Nova Scotia in 1976. Cold winds off the Northumberland Strait are a factor in delaying the beginning of plant growth in Inverness County, Nova Scotia (Hall et al. 1963).

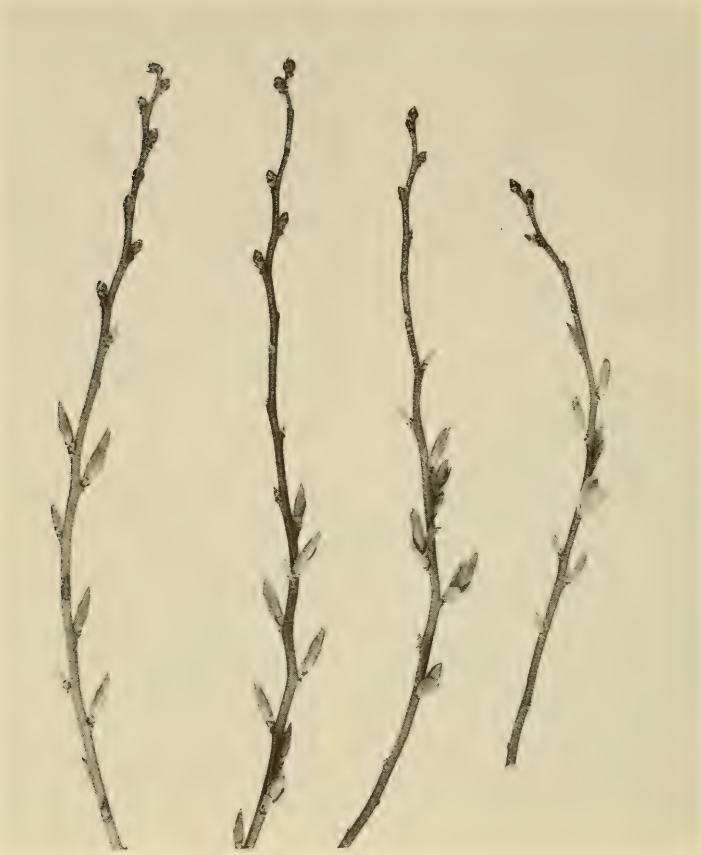

FIGURE 3. Winter injury on shoots of *Vaccinium angustifolium*.

In New Brunswick, Hall (1955) found that 0.5% of full sunlight under a *Picea rubens – Abies balsamea* canopy (Red Spruce - Balsam Fir) gave a minimum growth or just survival, 10% sunlight under a *Betula populifolia* canopy (Oldfield Birch) gave moderate vegetative growth but no flowering, and 50% sunlight (openings in canopy) gave flowering and fruiting.

Seed germination occurs only after periods of prolonged rainfall in late summer or early fall. Vander Kloet (1976a) found that seedling density was higher in a field sampled in Pictou County, Nova Scotia than in an old field at Leeds County, Ontario and he correlated this with higher precipitation and soil moisture.

Relative humidity may play an important role in fruit production. In dry years areas along the Atlantic coast have produced exceptional crops. Plants in the coastal fog belt are frequently covered with water droplets while plants farther inland experience stress from lack of moisture (e.g., withered berries, browned leaf margins).

(*b*) *Physiographic relations.* One of the most important factors limiting flowering and fruit development is the occurrence of late spring frosts on low-lying areas (Jackson et al. 1972b). Laboratory tests have shown that 6 h of –2.2°C were detrimental and a further reduction to –3.3°C for 6 h markedly reduced fruit set (Hall, Aalders, and Newbery 1971). *Vaccinium angustifolium* grows, yields, and reproduces well by rhizomes on both mineral and organic soils provided adequate moisture and aeration are available. It tolerates a wide range of soil conditions with best growth at low pH levels (Hall, Aalders, and Townsend 1964). In soils with much humus, most rhizomes grow in the top 5 cm. Jackson et al. (1972a) reported that soils such as Westbrook loam and Southampton sandy loam with a high percentage of stone or gravel provide the conditions most favorable to the emergence, growth, and development of seedlings.

(*c*) *Nutrient and water relations.* At the time of flower bud initiation the following suggested levels of nutrients (as % dry weight) should exist in the leaves (Townsend and Hall 1970): N, 1.50–2.00; P, 0.08–0.12; K, 0.40–0.55; Ca, 0.40–0.65; and Mg, 0.15–0.20. Lockhart (1959) first described the symptoms of mineral deficiency in *V. angustifolium*. Rayment (1965) clearly demonstrated the beneficial effects of applications of nitrogen to stands of *V. angustifolium* in Newfoundland.

Townsend et al. (1968) reported that sugars were lower, and starch was notably higher, in the rhizomes than in the leaves. Barker et al. (1963) found that the reducing sugars in fruits of five different clones varied between 7.4 and 7.9% of fresh weight.

Once established, the rhizone system of this species plays an important role in preventing slope erosion. If soil particles are washed into the network of rhizomes and shoots, new roots and shoots develop in the additional soil, favoring the plant and retaining the soil. The taproot system (Hall 1957) may penetrate to >1 m soil depth, allowing use of subsoil moisture reserves. Laycock (1967) states that the concentration of roots and rhizomes near the surface in the pine barrens of New Jersey allowed *V. angustifolium* and other species to absorb much of the water from light rains that fell during the growing season. The nutrient and pH requirements and competitive ability of this polymorphic species invite further investigation.

5. *Plant Communities.* Within the largely undisturbed part of its range, *V. angustifolium* is an important member of exposed headland vegetation, raised bogs, high moors, outcroppings on the Canadian Shield, mountain summits in the Gaspé, as well as in the herb–dwarf shrub stratum of open to moderately shaded pine to spruce woodlots and forests on coarse textured, mainly infertile soils in the Acadian, Great Lakes – St. Lawrence and Boreal Forest Regions of Rowe (1972), from Lake Winnipeg to the Atlantic coast.

But the species is most abundant in disturbance communities which result from clear-cutting, forest fires, and abandonment of agricultural land. The latter is especially noteworthy in the Maritime Provinces where, with a decline in soil fertility, land was abandoned during the early part of this century, providing many old field habitats for this species to colonize. Conners (1972) reports that by the late 1940s several of these fields were being cultivated. With the introduction of frozen foods on the American market a rapid development of the stands and industry took place.

Table 1 shows the contrasts among the floristic composition of three community types: (1) blueberry barrens on mainland Nova Scotia, (2) granite outcroppings near Kaladar, Ontario and, (3) the boreal conifer-hardwood forests of the Great Lakes region. Aside from *V. angustifolium*, the three community types have floristically little in common. Out of 71 species, excluding lichens and those with less than five occurrences, only *V. myrtilloides* (Sour-top Blueberry), *Gaultheria procumbens* (Teaberry), *Fragaria virginiana* (Wild Strawberry), *Rumex acetosella* (Sheep Sorel), and *Maianthemum canadense* (Wild Lily-of-the-Valley) are shared.

Maycock and Curtis (1960) have shown that *V. angustifolium* is an important component in both dry and wet sites of the boreal coniferous forest, but is unimportant on mesic sites. In Wisconsin, Curtis (1959) showed that it is the most prevalent groundlayer species in the northern dry forest and also an important constituent of northern dry-mesic forest, northern wet forest, bracken-grassland, and open bog. Lamoureux and Grandtner (1977) showed that this species was important in dune formation on Iles-de-la-Madeleine. Lavoie (1968) has described the Jack Pine (*Pinus banksiana*) forests with a *Kalmia angustifolia-Vaccinium* understory for the Lac de St. Jean area of Quebec. Community descriptions and tabulations of *V. angustifolium* in the Maritime Provinces are given by Hall (1955, 1959, 1975), Hall and Aalders (1968), and Hall et al. (1973, 1974, 1976).

6. *Growth and Development*

(a) Morphology. In the lowbush blueberry seedling (Figure 4) the oblong-elliptical cotyledons are about 2 mm long. The first seedling leaves are much smaller and usually more elliptical than mature leaves, making identification of young seedlings difficult. Stages in seedling development are given by Eaton and Hall (1961). Plants rarely flower or produce rhizomes until 4 yr after germination (Hall 1953). After plants reach a total width of 30 cm and rhizome growth occurs in several directions, expansion of the clone is more rapid. Rhizomes may grow up to 10 cm/yr on mineral soils and up to 50 cm on organic soils. Clones with intact rhizomes 10 m long have been excavated in Kings County, Nova Scotia. The minimum age of a parent clone may be estimated by counting growth rings from rhizome cross-sections (Figure 5). The importance of rhizome growth in the expansion of the clone has been outlined by Barker and Collins (1963b).

(b) Physiology. Forsyth and Hall (1965) have shown that photosynthesis is more rapid in the early morning and that temperature, CO_2 and leaf age affect photosynthetic rates. Rates of apparent photosynthesis in shoots at different light intensities have been reported by Bonn et al. (1969). Red leaf infected leaves (see 9(c)) and genetic mutant leaves had abnormally lower photosynthetic rates (Hall, Forsyth, Lockhart, and Aalders 1966). Strong

TABLE 1—*Vaccinium angustifolium* Aiton, associated species on six granitic outcroppings from Kaladar, Lennox-Addington County to Mount Fitzsimmons, Leeds County, eastern Ontario; two barrens* on mainland Nova Scotia; and 11 dry Boreal Conifer – Hardwood Forests of the Great Lakes Region**

Species	Frequency of occurrence (%)		
	Eastern Ontario	Mainland Nova Scotia	Great Lakes region
Bare ground, rock, or litter	789 (21.6)	1716 (17.2)	NA
Epipetric lichens	522 (14.3)	—	NA
Fruticose lichens	210 (5.8)	—	NA
Polytrichum commune	28 (0.8)	199 (2.0)	NA
Polytrichum juniperinum	151 (4.1)	—	NA
Polytrichum piliferum	33 (0.9)	—	NA
*Lycopodium annotinum****	—	—	(12)
Lycopodium clavatum	—	6	(21)
Lycopodium obscurum	—	44 (0.4)	(22)
Lycopodium complanatum	—	6 (0.06)	(1)
Pteridium aquilinum	—	59 (0.6)	(78)
Juniperus communis	91 (2.5)	—	—
Danthonia spicata	159 (4.4)	536 (5.4)	—
Deschampsia flexuosa	144 (3.9)	—	—
Poa compressa	30 (0.8)	—	—
Agrostis scabra	6 (0.2)	—	—
Panicum subvillosum	—	14 (0.1)	—
Oryzopsis asperifolia	—	—	(8)
Carex pensylvanica	228 (6.2)	—	(3)
Carex nigromarginata	23 (0.6)	—	—
Carex umbellata	8 (0.2)	—	—
Luzula multiflora	—	6 (0.06)	—
Clintonia borealis	—	—	(17)
Maianthemum canadense	15 (0.4)	8 (0.08)	(66)
Salix bebbiana	—	35 (0.35)	—
Betula populifolia	—	30 (0.3)	—
Corylus cornuta	—	—	(23)
Rumex acetosella	47 (1.3)	4 (0.04)	(1)
Comandra umbellata	66 (1.8)	—	—
Anemone quinquefolia	—	—	(8)
Dalibarda repens	—	—	(8)
Spiraea alba	18 (0.5)	—	(1)
Spiraea latifolia	—	60 (0.6)	—
Spiraea tomentosa	—	29 (0.3)	—
Amelanchier sanguinea	11 (0.3)	—	—
Amelanchier spicata	19 (0.5)	—	—
Prunus virginiana	9 (0.3)	—	—
Prunus serotina	7 (0.2)	—	—
Pyrus melanocarpa	163 (4.5)	—	—
Rubus arundelanus	12 (0.3)	—	—
Rubus hispidus	—	41 (0.4)	—
Rubus idaeus	—	—	(6)
Waldsteinia fragarioides	—	—	(18)
Fragaria virginiana	5 (0.1)	39 (0.4)	(3)
Potentilla tridentata	—	46 (0.5)	—
Potentilla simplex	—	84 (0.8)	—
Polygala paucifolia	—	—	(22)
Rhus copallina	9 (0.2)	—	—
Rhus typhina	11 (0.3)	—	—
Aralia nudicaulis	—	—	(33)
Cornus canadensis	—	389 (3.9)	(61)
Ledum groenlandicum	—	14 (0.1)	—
Rhododendron canadense	—	106 (1.1)	—

TABLE 1—*(Concluded)*

Species	Frequency of occurrence (%)		
	Eastern Ontario	Mainland Nova Scotia	Great Lakes region
Kalmia angustifolia	—	3271 (32.7)	—
Arctostaphylos uva-ursi	61 (1.7)	—	—
Gaultheria procumbens	23 (0.6)	348 (3.5)	(21)
Vaccinium myrtilloides	32 (0.9)	1 (0.01)	(20)
Vaccinium angustifolium	528 (14.5)	2139 (21.4)	(51)
Vaccinium vitis-idaea	—	27 (0.27)	—
Gaylussacia baccata	54 (1.5)	—	—
Trientalis borealis	—	—	(39)
Melampyrum lineare	—	—	(19)
Linnaea borealis	—	—	(12)
Viburnum rafinesquianum	21 (0.6)	—	—
Lonicera canadensis	—	6 (0.06)	—
Diervilla lonicera	8 (0.2)	—	—
Helianthus divaricatus	26 (0.7)	—	—
Aster cordifolius	8 (0.2)	—	—
Aster macrophyllus	—	—	(33)
Solidago puberula	—	648 (6.5)	—
Solidago rugosa	—	6 (0.06)	—
Solidago graminifolia	—	15 (0.15)	(3)
Antennaria neglecta	—	12 (0.12)	(1)
Prenanthes trifoliolata	—	5 (0.05)	—
Hieracium aurantiacum	—	8 (0.08)	(12)
Hieracium pratense	—	5 (0.05)	—
34 spp. with fewer than 5 occurrences	46 (1.3)	10 (0.1)	NA
Totals	3650 (100)	10,000 (100)	11 Stands

*Data from Hall and Aalders (1968) slightly modified and reduced.
**Data from Maycock and Curtis (1960) slightly modified and reduced.
***Scientific nomenclature of vascular plants follows *Gray's Manual of Botany* (Fernald 1950).

vegetative growth results when plants of different provenances are given 16 h light and 8 h dark periods per 24 h at 18°C. Flower buds are formed when plants are given 12 h light and 12 h dark per 24 h at 18°C. Hall et al. (1970) have shown that leaf anthocyanin concentration increases as the temperature decreases. *Vaccinium angustifolium* leaves develop brilliant red or yellow coloration in autumn.

(c) Phenology. Vaccinium angustifolium overwinters in a leafless state, with twigs yellow to reddish brown. At Kentville, vegetative and flower buds swell in early May if air temperatures have exceeded 10°C for 3–4 d. Flowering occurs from late May to mid-June. In cooler coastal areas, flowering may be delayed 2–3 wk (Bell 1953). Leaf development precedes, is concomitant with, or follows flowering depending on the particular clone. Leaves harden by mid-July, turn red in late August, and abscis by late October. In seasons following a burn-prune, vegetative growth commences a week after flower bud expansion and terminates in early July. Termination of shoot growth as evidenced by a black tip in the apical meristem (Bell 1950) occurs earlier on older unpruned bushes (Barker and Collins 1963a). Berries ripen in early August at Kentville, 2–3 wk earlier than in Cumberland County, Nova Scotia (Aalders et al. 1972). Flower primordia begin to develop shortly after cessation of vegetative growth (Bell and Burchill 1955a), but continue until late October if air temperatures remain $>0°C$ with extended periods greater than 10°C. Thus temperature is an important regulator of plant phenology. But other factors including day length are important (Hall et al. 1970). At Lac de St. Jean, Quebec, flower bud formation is poor in some years, probably owing to early frosts. Hall and Ludwig (1961) have shown that different clones react differently to day length and temperature. By winter, primordia of all the floral organs are microscopically recognizable (Bell and Burchill 1955b).

Kender (1968) found that growth potential of rhizome buds was greater in early spring and late summer than in July.

FIGURE 4. Sweet Lowbush Blueberry seedlings. Approximate age 3 yr upper left and 4 yr lower right. The latter has begun to form a rhizome (indicated by arrow).

7. *Reproduction*

(a) Floral biology. The flowers are insect pollinated, but not very attractive to bees, probably because the nectar volatiles are simple acetaldehyde and ethanol (Hall, Forsyth, Lightfoot, and Boch 1971). The stamens and pistil are functional as soon as the flower fully opens. The pistil remains highly receptive under field conditions for 4 d but fertility drops to about 20% by the 7th d (Wood 1962). Wood (1961a) also found that nectar volume and weight of nectar sugar increased with the flower age. After pollination the corolla turns pink and deteriorates very rapidly. This is associated with a marked increase in ethylene production (Hall and Forsyth 1967) and a high rate of respiration (Forsyth and Hall 1969) which persists through the small green fruit stage.

Glasshouse studies indicate that flowers selfed using pollen from the same flower or any flower of the same clone do not generally set fruit (Aalders and Hall 1961). The results of intercrossing and selfing six clones of *V. angustifolium* are given in Table 2. The vascular anatomy of the ovary has been described by Bell and Giffin (1957).

(b) Seed production and dispersal. It is rare to find a seedless fruit of *V. angustifolium* even in highly productive clones. Table 2 shows the number of seeds per berry in crosses completed in 1977 and 1978 among six clones.

Seeds are spread in the droppings of birds and mammals. The American Robin (*Turdus migratorius*) is a major seed disperser in southwestern New Brunswick as it often feeds and migrates just before fruit harvest by man (Eaton 1957). We have found seeds of *V. angustifolium* in the droppings of Black Bear (*Ursus americanus*), Red Fox (*Vulpes vulpes*), and Raccoon (*Procyon lotor*).

TABLE 2—Cross- and self-fertility of six selected clones of *Vaccinium angustifolium* in glasshouse trials, Kentville, Nova Scotia, 1977–1978

Female	Male	Percent of pollinated flowers forming fruits[1]	No. seeds per berry[2]	No. seeds per 100 pollinations	Percent seed germinations[3]
Augusta	× Brunswick	100	31	3100	88
	× Chignecto	70	24	1680	97
	× 510	65	25	1625	98
	× ME3	81	55	4485	93
	× ME4161	61	49	3026	88
	× Self	56	10	568	89
Brunswick	× Augusta	0	—	0	—
	× Chignecto	0	—	0	—
	× 510	2	16	39	94
	× ME3	2	20	49	90
	× ME4161	0	—	0	—
	× Self	0	—	0	—
Chignecto	× Augusta	74	30	2249	88
	× Brunswick	65	17	1131	91
	× 510	55	24	1298	90
	× ME3	56	28	1548	98
	× ME4161	45	25	1125	95
	× Self	0	—	0	—
510	× Augusta	12	46	580	84
	× Brunswick	95	34	3230	80
	× Chignecto	80	33	2632	86
	× ME3	11	41	461	82
	× ME4161	0	—	0	—
	× Self	0	—	0	—
ME3	× Augusta	18	37	644	89
	× Brunswick	65	39	2535	94
	× Chignecto	14	38	521	89
	× 510	6	22	140	95
	× ME4161	1	14	18	93
	× Self	0	—	0	—
ME4161	× Augusta	42	21	892	97
	× Brunswick	29	23	673	93
	× Chignecto	26	16	410	90
	× 510	39	23	907	91
	× ME3	75	30	2235	92
	× Self	14	6	77	74
Crosses		30.6%	29	1241	82
Selfs		11.7%	8	108	90

[1]Based on a sample of 20–80 hand-pollinated flowers.
[2]Seeds used here were the perfect ones, according to Bell (1957).
[3]Based on four lots of 50 seeds each, or on fewer if 200 not available.

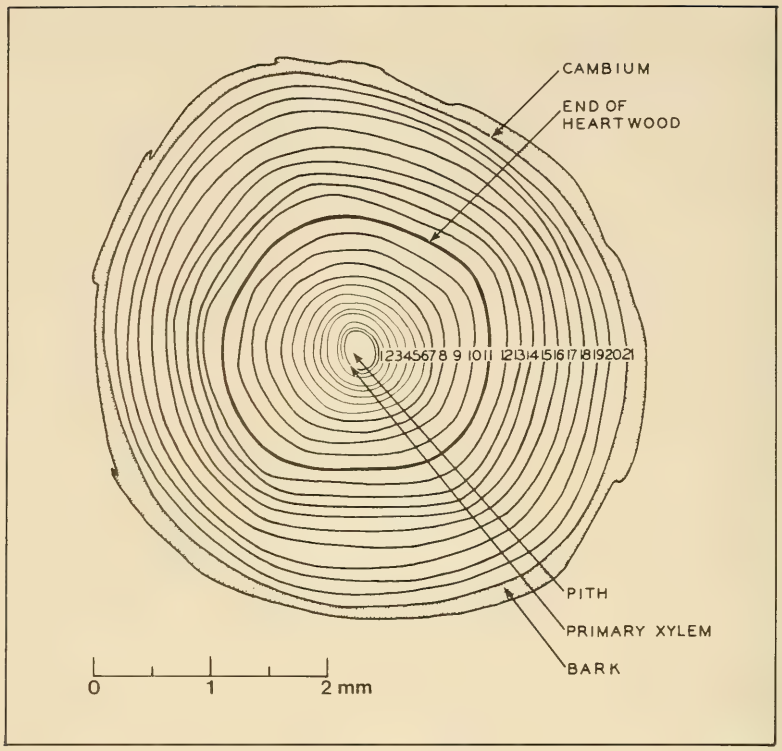

FIGURE 5. Cross-section of a *Vaccinium angustifolium* rhizome showing 21 growth rings. Counting these rings provides an estimate of the minimum age of the parent clone.

The number of seed (up to 64) found in a berry depends on genetic factors and environmental conditions. If weather is favorable (warm and dry) for insect pollination during the period of stigma receptivity, berries will have higher seed counts.

(c) Seed viability and germination. Fresh seed of *V. angustifolium* extracted from well ripened berries germinates readily at 21°C under 16 h light per 24-h period (Table 2) and usually takes 21 d. Germination is greater in light than in dark (G. W. Wood, personal communication). Seeds can be stored dry or frozen in fruit for 6 mo with no major reduction of viability (Aalders and Hall 1975). Seeds of *V. angustifolium* germinate well when sown on a soil mix, pH 4.7 in the glasshouse.

(d) Vegetative reproduction. Asexual reproduction occurs when the rhizomes are cut or killed by fire, shading, burrowing and/or frost action whereas sexual reproduction predominates in areas where the soil has recently been denuded by cultivation, flooding, or blow down of forest trees.

Plants may be propagated from either rhizome or stem cuttings. At Kentville, stem cuttings are taken just after black tip formation (6(*c*)) in early July and rooted under intermittent mist for 6 wk, with about 80% success (Hall et al. 1977). Studies of *in vitro* culture techniques for propagation are in progress (Nickerson and Hall 1976; Nickerson 1978).

8. *Population Structure and Dynamics*

Since dispersal is through bird and mammal droppings, one would expect a clumped dispersion pattern, and random sampling of three abandoned meadows with 28 1-m^2 quadrats in Pictou County, Nova Scotia gave a mean $\pm$ SE of 1.1 ± 0.39 seedlings, variance of 4.54, and a variance mean ratio of 4.3:1, confirming that expectation. One quadrat had a clump of 17 seedlings, the remainder one or none, rarely two seedlings. Seedlings may initially be clumped but as Vander Kloet (1976a) has shown, both in Nova Scotia and Ontario, seedling mortality is very high, i.e., $> 99\%$ of germinating seeds died even under partially controlled conditions.

The shoot crown diameters of plants established by seed can be converted to age classes according to a formula devised by Eaton and Hall (1961). Using this size-age relationship, Vander Kloet (1976b) found a marked difference in the age structure of *V. angustifolium* in old fields in eastern Ontario and eastern Nova Scotia. In the former, all seed-established plants exceeded 40 yr of age; in the latter the 11–20 yr age class was the most frequent.

On stable habitats such as mountain summits, exposed headlands, or outcroppings in the Canadian Shield, colonies of *V. angustifolium* may attain considerable age. Clones attain large size (>10 m diameter) and age (>150 yr). Vander Kloet (unpublished data) studied the species composition and population patterns of granitic outcrop communities in the Thousand Island region of Ontario and New York over a 10-yr period. Little or no change in species composition or abundance was observed; however, the positions of colonies of *V. angustifolium, Juniperus communis* (Common Juniper), and *Pyrus melanocarpa* (Black Chokeberry) shifted laterally. Vigorous peripheral branches of *Juniperus* shaded out colonies of *Vaccinium* and *Pyrus*, while the latter two invaded the senescing centers of *Juniperus* colonies. Similarly *Pyrus* and *Vaccinium* invaded the senescent portions of each other's colonies.

Turnover rates in *V. angustifolium* populations may be more rapid in the maritime provinces where the species is often a common component of old field succession, reaching peak abundance 15–25 yr after abandonment. By the judicious use of fire, this seral stage can be maintained as blueberry barrens for many years. Ordinarily the low growing *V. angustifolium* is soon shaded out by a variety of hardwood or conifer tree species. Once the forest canopy fully develops, it becomes uncommon and/or sterile. *Vaccinium myrtilloides* has a much higher survival potential than *V. angustifolium* in the mature Acadian boreal forest (Hall 1959).

9. *Interaction with Other Species*

(a) Competition. Competing plant species may be treated in four ecological site groups: (1) undisturbed natural; (2) post-logging; (3) old field; (4) blueberry crop.

On undisturbed natural sites within its range of suitable habitats, *V. angustifolium* has many competitors, as may be seen in Table 1. In relatively stable and oligotrophic *Pinus banksiana* woodlands and *Picea mariana* (Black Spruce) forests of the Boreal Forest and Great Lakes – St. Lawrence Regions (Rowe 1972) east of Lake Winnipeg, its major competitors for nutrients, water, and light in the herb–dwarf shrub stratum include *V. myrtilloides, Cornus canadensis* (Bunch Berry), *Gaultheria hispidula* (Creeping Snowberry), *Coptis groenlandica* (Goldthread), *Pteridium aquilinum* (Bracken Fern), *Clintonia borealis* (Corn-lily), *Comptonia peregrina* (Sweet-fern), *Maianthemum canadense,* and *Lycopodium* spp. Major competitors in the low shrub stratum include *Kalmia angustifolia* (Lambkill), *Ledum groenlandicum* (Labrador-tea), and *Diervilla lonicera* (Bush Honeysuckle).

On post-logging sites in eastern Canada, surviving and/or invading *V. angustifolium* populations must compete with surviving species that respond favorably to clearing, e.g., *Pteridium aquilinum* (Cody and Crompton 1975), *Dennstaedtia punctilobula* (Hay-scented Fern) (Cody et al. 1977), and *Cornus canadensis* (Hall and Sibley 1976), as well as with aggressive invader species, e.g., *Epilobium angustifolium* (Fireweed).

On old field sites in the Acadian Forest Region (Rowe 1972) *V. angustifolium* is an important seral species in the transition stage between field and forest. On coarse-textured soils in old fields of Prince Edward Island, *Myrica pensylvanica* (Bayberry) succeeds *V. angustifolium* before the *Picea glauca* excludes both (Hall 1975). On light sandy soils of the Lac de St. Jean of Quebec, *Comptonia peregrina* is a major invader of blueberry stands (Lavoie 1968).

Members of the blueberry crop group offer competition because they thrive under the cultural practices pertaining to lowbush blueberry culture. Probably the strongest competitor for space is *Kalmia angustifolia* (Hall et al. 1973). Its stem growth following burn-pruning exceeds that of *V. angustifolium* (Hall and Aalders 1968). Fertilizing stands of lowbush blueberry increases the growth of *Pyrus melanocarpa* relative to that of *V. angustifolium* (Hall et al. 1978). On poorly drained areas *Rhododendron canadense* (Rhodora) and *Spiraea latifolia* (Meadow-Sweet) (Hall et al. 1974) replace *V. angustifolium.*

(b) Symbiosis. The principal native pollinators in Maine and eastern Canada are species of Halictidae and Andrenidae although a few species of Bombidae, Anthophoridae, Colletidae, and Xylocopidae are of some importance (Boulanger et al. 1967). In eastern Ontario Vander Kloet (1976c) found that the solitary bees *Andrena vicina* and *A. carlini,* and the bumblebees *Bombus bimaculatus, B. terricola,* and *B. ternarius* were the important pollinators. Wood (1961b) found honeybees effective during a short period of bloom in New Brunswick.

Mycorrhizal associations in *V. angustifolium* were described by M. MacArthur (1955. Mycorrhiza in the

blueberry. *In* Horticulture Division, Central Experimental Farm, Ottawa, Progress Report 1949-53. pp. 71–72) but the fungi involved were not identified.

(c) Predation and parasitism. Foliage of *V. angustifolium* is eaten by Black Bear (*Ursus americanus*), Eastern Cottontail (*Sylvilagus floridanus*), and White-tailed Deer (*Odocoileus virginianus*). Fruits are eaten by a number of mammals and many birds (Martin et al. 1951).

The important insects are Blueberry Maggot, *Rhagoletis mandax* Cn.; Black Army Cutworm, *Actebia fennica* (Tausch.); Chainspotted Geometer, *Cingilia catenaria* (Drury); Blueberry Flea Beetle, *Altica sylvia* Mall.; Blueberry Casebeetle, *Chamisus cribripennis* (LeConte) (see Wood 1978); Blueberry thrips, *Frankliniella vaccinni* Morgan and *Catinathrips kainos* O'Neill; Blueberry Tipworm, *Contarinia vaccinii* Felt.; sawflies, *Neopareophora litura* Klug, *Pristiphora idiota* Nort., *Pristiophora* sp.; Red-striped Fireworm, *Aroga trialbamaculella* Chamb.; and Stem Galler, *Hemadas nubilipennis* Ashm.

The stage of the life cycle of these insects which affects *V. angustifolium*, the manner of infection, the symptoms for recognition, and other details are given in Hall et al. (1975).

The important fungal diseases (Conners 1967) are monilinia blight caused by *Monilinia vaccinii-corymbosi* (Reade) Honey; botrytis blight (*Botrytis cinerea* Pers.); red leaf (*Exobasidium vaccinii* Wor.); witches-broom (*Pucciniastrum goeppertianum* (Kühn) Kleb.); dieback (*Diaporthe vaccinii* Shear); powdery mildew (*Microsphaera penicillata* (Wallr. ex Fr.) Lev. var. *vaccinii* (Schw.) W. B. Cke.); leaf rust (*Pucciniastrum vaccinii* (Wint.) Jorstad); leaf spot (*Septoria* sp.); Gloeosporium leaf spot (*Gloeosporium minus* Shear); and canker (*Godronia cassandrae* Pk. f. *vaccinii* Groves). A *V. angustifolium* plant which showed symptoms of shoestring virus disease was reported by Lockhart and Hall (1962).

(d) Toxicity and allelopathy. None reported to date.

10. *Evolution and Migration.* Camp (1942), on the basis of meager and unsubstantiated evidence (Vander Kloet 1978), assumed that *V. angustifolium* was a diploid species (i.e., gametes had 12 chromosomes) but as was pointed out in section 1(*h*) this cannot be confirmed. Therefore his allopatric speciation model for the species is also doubtful since Camp (1942) argued, rightly, that processes leading up to speciation in diploid populations differ markedly from those which give rise to tetraploid species. Vander Kloet (1977) has postulated a recent hybrid origin for *V. angustifolium*. He proposes that *V. boreale* migrated south or moved down mountain slopes where it came into contact with *V. pallidum* Ait. (Upland Low Blueberry) of oak-pine woods. Both of these species are diploids and by spontaneous chromosome doubling in a hybrid, an allotetraploid species is plausible.

Probably *V. angustifolium* migrated into the northern part of its habitat from the southern United States following the retreat of the last glacial ice. Birds doubtless accelerated this migration by dispersing seeds across water bodies and other habitat barriers.

An initial attempt has been made to separate clones of *V. angustifolium* on the basis of chlorophyll and anthocyanin content of bark from shoots (Wood and Barker 1963).

11. *Response Behavior*

(a) Fire. In natural communities or managed forests *V. angustifolium* survives wild fire or controlled burning below ground. Recolonization occurs by rhizome sprouting. Commercial stands are burn-pruned every second year resulting generally in unbranched stems which have more flower buds per stem and more flowers per bud than on older wood. There were no significant differences between fall- and spring-burned plants with respect to amount of shoot growth and number of flower buds per shoot (Hall, unpublished). Burning after the plants were in full leaf was detrimental to new shoot growth and flower bud formation (Eaton and White 1960). Black (1963) found that total fruit production over a 9-yr period was greater from burning every second year than from burning every third year. Smith and Hilton (1971) found that improved lowbush blueberry performance in Ontario after burning resulted mainly from the stimulative effects of nutrients in ash deposited on the surface soil.

(b) Grazing and harvesting. In New Brunswick, sheep were observed to graze grasses and sedges selectively rather than feed on *V. angustifolium* and *V. myrtilloides* (Hall, I. V. 1954. Ecological studies. *In* Dominion blueberry substation, Tower Hill, New Brunswick progress report 1949–1953. Canada Department of Agriculture. pp. 18–23). Removal of shoot tips by browsing White-tailed Deer (*Odocoileus virginianus*) results in lateral branching.

(c) Flooding. During the dormant period *V. angustifolium* can withstand considerable flooding such as that which occurs in many bogs, but it is not characteristic of wet habitats such as marshes or lake margins.

(d) Drought. During prolonged drought in early summer shoot growth is reduced. Dry weather later in the season results in shriveling of fruit and reduced flower bud formation. Irrigation prior to harvest substantially increases fruit size.

(e) Herbicides. 2,4-D causes a twisting of the terminal growth followed by browning and leaf fall. No data are available on other herbicides.

12. *Relationship to Man*

The fresh fruits of *V. angustifolium* have been a part of man's diet in North America since prehistoric times. Indians dried and pulverized fruits for blending with meat (Hedrick 1919). European settlers collected and preserved the fruit for jam, jelly, and preserves as well as eating them raw. These are still the main uses, but new products such as muffin mixes, ice cream, yogurt, and wine (Hope 1965) are using considerable quantities of fruit. For commercial use the fruits are quick-frozen by passing them through a tunnel of air at −29° to −34°C. For many years the only fruit markets for the species were in Canada and the United States. Recently the fruit has found some acceptance in western Europe where it competes with the European *V. myrtillus* L.

The area of lowbush blueberries under management is expanding each year in the Atlantic Provinces, which have programs for assisting growers to develop existing stands of *V. angustifolium.* Agriculture Canada is also providing funds through the New Crop Development Fund to determine the cost and feasibility of establishing plantings of this species within its range.

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Notes

Mosses New to Ontario and Quebec

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Ireland, Robert R. and Gilda Bellolio-Trucco. 1979. Mosses new to Ontario and Quebec. Canadian Field-Naturalist 93(4): 431–433.

Five mosses are reported new to the bryoflora of Ontario (*Cinclidium latifolium, Drepanocladus revolvens* var. *intermedius, Hypnum hamulosum, Myurella tenerrima, Orthothecium strictum*) and five new to Quebec (*Atrichum tenellum, Fissidens obtusifolius, Hypnum hamulosum, Orthotrichum strangulatum* fo. *lescurii, Pseudoleskeella catenulata*).

Key Words: mosses, Ontario and Quebec flora, geographical distribution, new records.

Recent collecting by the authors and others have accounted for several new additions to the moss flora of Ontario and Quebec. The Ontario records are new to the checklist of Ireland and Cain (1975), while the Quebec mosses are not listed by Lepage (1947), Kucyniak (1948, 1949, 1950a, b, c, 1952a, b, c, 1961), Löve et al. (1958), LeBlanc (1949, 1951, 1954, 1963), or Masson (1967). In the case of *Fissidens obtusifolius* Wils., Lepage (1947) reported it for Quebec but LeBlanc (1963) later deleted it from the flora.

The purpose of this paper is to report four species and one variety new to Ontario and four species and one form new to Quebec. Voucher specimens are deposited in the National Herbarium of Canada (CANM) in Ottawa.

New to Ontario

Cinclidium latifolium Lindb.

Kenora District: 56°45′N, 88°45′W, coastal raised beach-sedge meadow system, *Kershaw*, July 1972 (CANM *242656*).

An interesting moss collected by Kershaw (1974) in his studies of the raised beaches in northwestern Ontario, this species is a circumpolar arctic-alpine calciphile that was previously known in Canada from northern Manitoba, Yukon Territory, and Northwest Territories. Mogensen (1973) has mapped its worldwide distribution.

Drepanocladus revolvens var. *intermedius* (Lindb. *ex* C. Hartm.) Grout

Bruce County: Cemetery Road, Caesar's Bog, *C. Williams 1107*. Cochrane District: island in Moose R. near mouth of Abitibi R., 51°03′N, 80°57′W, *Baldwin B-22*. Rainy River District: 5 mi [8 km] NE of Gameland, *Garton 9263*. Thunder Bay District: Sibley Peninsula, bog at NW corner of Middlebrun Bay, 2.75 ml [4.4 km] NE of Silver Islet, *Garton 4362*.

Ireland and Cain (1975) considered this variety a synonym of the typical variety; however, there has been so much debate (Steere 1978) regarding its taxonomic status that we have decided to recognize it as a distinct taxon until a detailed study can be made.

The variety *intermedius* is a calciphile that is also known from British Columbia, Newfoundland, Yukon Territory, and Northwest Territories.

Hypnum hamulosum B.S.G.

Kenora District: 56°45′N, 88°45′W, coastal raised beach-sedge meadow system, *Kershaw,* July 1972 (CANM *242653*). Verified by H. A. Crum.

Another calcicolous arctic-alpine species, like *Cinclidium latifolium*, that was collected by Kershaw (1974) in his raised beaches studies, this species has been reported for all Canadian provinces and territories except Prince Edward Island and New Brunswick. Its presence in Newfoundland (Macoun and Kindberg 1892) and Nova Scotia (Erskine 1968) seems doubtful, however. Ando (1972) has mapped the worldwide distribution of this *Hypnum*, as well as others that occur in North America.

Myurella tenerrima (Brid.) Lindb.

Thunder Bay District: Ouimet Canyon, 10 km W of Dorion, 48°43′N, 88°40′W, *Garton 11634, 15365, 15371*; canyon at NW corner of Cavern Lake, 16 km NNW of Dorion, 48°50′N, 88°41′W, *Garton 14997, 15098*.

This calcicolous arctic-alpine species is now known from all provinces and territories in Canada except Saskatchewan, Newfoundland, New Brunswick, Nova Scotia, and Prince Edward Island. Its occurence in Ouimet and Canyon Lake canyons is extremely interesting as other arctic mosses, such as *Aulacomnium acuminatum* (Lindb. & H. Arnell) Kindb. (Williams 1968) and *A. turgidum* (Wahlenb.) Schwaegr. also occur there, reaching their southern limit in these two Ontario localities. These mosses are arctic relicts

that have been able to survive at the bottom of these canyons far south of their present ranges because of the cold microenvironment created among huge boulders.

Orthothecium strictum Lor.

Kenora District: south shore Attawapiskat River, 52°52′N, 83°45′W, *Riley 6512*.

This is a circumboreal arctic-alpine calciphile that is also known in Alberta, Quebec, Newfoundland, Yukon Territory, and Northwest Territories.

New to Quebec

Atrichum tenellum (Roehl.) B.S.G.

Gatineau County: Gatineau Park, trail N of Champlain Lookout, NW of Hull, 45°30′N, 75°54′W, *Ireland, Iwatsuki & Kuc 9684*. Determined by G. L. Smith.

This collection was originally identified as *A. crispum* (James) Sull. & Lesq. but G. L. Smith discovered the misidentification and informed the senior author (personal communication) that it represented a species new to North America. Ireland (1971) subsequently reported the species for southern British Columbia and Quebec but without specific collection data. The species is now known from scattered localities in British Columbia, Manitoba, Ontario, Labrador, Newfoundland, Prince Edward Island, and New Brunswick.

Fissidens obtusifolius Wils.

Gatineau County: Stag Creek, near Low, ca. 45°48′N, 76°07′W, *Ireland & Bellolio-Trucco 18099*.

This distinct calciphile, which was reported by Lepage (1947) for Quebec, was later deleted from the flora by LeBlanc (1963). It is probably rare in the province but it may eventually be found in other localities in southern Quebec. It seems to be restricted to eastern Canada where it is also known from southern Ontario.

Hypnum hamulosum B.S.G.

James Bay region, 54°53′N, 79°08′W, *Lethiecq QFB-E 11498*.

This species is also reported as new to Ontario in this paper.

Orthotrichum strangulatum fo. *lescurii* (Aust.) Vitt

Gatineau County: Gatineau Park, Luskville Falls, NE of Luskville, 45°32′N, 76°00′W, *Ireland & Bellolio-Trucco 17922*. Determined by D. H. Vitt.

This form differs from the typical form *strangulatum*, which is also known from Quebec, in several minor variations of the gametophyte and sporophyte (Vitt 1973). The form *lescurii* has been reported for British Columbia and Ontario (Grout 1935) but its occurrence in British Columbia is doubtful according to Vitt (personal communication).

Pseudoleskeella catenulata (Brid. *ex* Schrad.) Kindb.

Gatineau County: Paugan Falls, 1 mi [1.6 km] E of Low, ca. 45°49′N, 75°55′W, *Ireland & Bellolio-Trucco 18050*.

This calcareous species is also known from Ontario, Labrador, and Northwest Territories. Lewinsky (1974), who mapped the worldwide distribution, showed a record in the Gaspé Peninsula but we have seen neither a literature report nor a herbarium specimen for that locality.

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Swans Wintering on Vancouver Island, 1977–1978

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McKelvey, Richard W. 1979. Swans wintering on Vancouver Island, 1977–1978. Canadian Field-Naturalist 93(4): 433–436.

An aerial survey of swans wintering on Vancouver Island, British Columbia in February 1978 revealed a minimum of 1065 birds. Most were believed to be Trumpeter Swans (*Olor buccinator*) although some Mute Swans (*Cygnus olor*) were present on southern Vancouver Island. Cygnets accounted for 21.5% of the total. Changes in wintering distribution were noted; the largest population shift was into the agricultural areas of Comox and Nanaimo.

Key Words: Trumpeter Swan, *Olor buccinator*, Mute Swan, *Cygnus olor*, wintering, Vancouver Island, estuaries.

Swans winter along the coast of western North America, from Alaska to southern Washington (Bellrose 1976). Counts of winter populations have generally been sporadic owing to the extent and remoteness of the winter habitat, except on Vancouver Island. Estimates of the number of swans wintering there have been made periodically over the last eight years. In 1977–1978 I conducted an aerial survey of Vancouver Island areas frequented by swans. Objectives of this survey were further to assess winter swan populations, determine the proportion of cygnets, and document changes in major concentration areas.

Methods

The survey, conducted 16–18 February 1978, covered most areas previously surveyed (D. Trethewey, personal communication) including most estuaries and lakes found to be ice-free. Northern Vancouver Island, from Cape Scott to Port Hardy,

was not surveyed because of poor weather; its omission is not considered important, because previous surveys recorded few swans there and habitat is limited.

A float-equipped Cessna 185 was flown at an altitude of approximately 215 m. Observations were made from both sides of the aircraft. In areas of high concentration the flocks were counted as the aircraft circled, and the counts were verified later from photographs.

Results and Discussion

Population Status

Table 1 compares results of the 1977–1978 survey with those of previous surveys. Vancouver Island has been divided into eight regions based on landforms (after Holland 1964). The regions and sighting locations are shown in Figure 1.

In the present study 1065 swans were counted, a result which is not substantially different from those reported previously. Smith and Blood (1972) estimated a peak population of 1076 in the period 1969–1971. This was based on the results of a single aerial count of 1013 birds in February 1971, and several estimates made by others (I. Smith and D. Trethewey, unpublished data). I. Smith and D. Trethewey recorded only 892 swans in 1972–1973. The variability between counts is reduced, however, when cygnets are eliminated from the comparison (Table 1). There seems to have been little or no increase in numbers of adult and subadult swans since 1969–1971. The estimate by Smith and Blood (1972) of a 129% increase over the 1969–1971 period may have resulted from incomplete surveys, or from the

TABLE 1—Swans counted during aerial surveys on Vancouver Island

Region	Number of swans (cygnets)		
	1970–71[1]	1972–73	1977–78
Parksville-Victoria	62	48(4)	229[2](45)
Barkley Sound	90	35(1)	109 (30)
Alberni Basin	1128	195(25)	97 (12)
Ucluelet-Quatsino	308	207(27)	166 (27)
Cape Scott	107	90(10)	44 (6)
Kelsey Bay	140	129(20)	76 (38)
Comox Valley	112	108(7)	246 (52)
Adults and immature	760	789	836
cygnets	246[3]	103	229

[1]From Smith and Trethewey (unpublished data).
[2]Including two Mute Swans.
[3]Based on an average of 24.3% cygnets, after Smith and Blood (1972).

FIGURE 1. Locations of swan sightings in the 1977–1978 winter survey.

inclusion of cygnets in their calculations. The year-to-year variation in cygnet production can be large, so estimates of population increases may be biased if cygnet numbers are included.

Much of the apparent increase on this survey may be the result of previous surveys not having considered resident Mute Swans (*Cygnus olor*) established locally from escaped park birds. I believe most swans I observed were Trumpeter Swans (*Olor buccinator*) as did Smith and Blood (1972). Both Mute Swans and Whistling Swans (*O. columbianus*), however, are regularly recorded on Vancouver Island in winter (British Columbia Provincial Museum sight records (BCPM)).

Records of Mute Swans on Vancouver Island extend back to at least 1945 (BCPM). The feral population had increased to at least 100 birds by 1972 (Tatum 1973). Christmas Bird Counts indicate that the population is still increasing but is confined to the Victoria-Ladysmith area (American Birds, Volume 25–32). Although only two Mute Swans were identified in the 1977–1978 survey, on Somenos Lake near Duncan, it seems likely that many more of the swans recorded in that area were of this species.

Few swans were reported in previous aerial surveys between Ladysmith and Victoria (Table 1). Because it is unlikely that Mute Swans were identified and excluded from the reported results of those surveys, they may have been concentrated in areas not thoroughly surveyed, such as Greater Victoria (D. Trethewey, personal communication). If Mute Swans in the Ladysmith-Victoria area were missed in previous surveys, their inclusion in my survey may be responsible for the apparent increase. The 65 adults I counted in that area is close to the number of Mute Swans reported (67) in the 1976–1977 Christmas Bird Count (Weseloh 1977, p. 457). Lowering the adult and subadult total for 1977–1978 by 65 gives a figure very close to those for 1970–1971 and 1972–1973 (Table 1).

Weekly counts of swans at Comox Harbour and Port Alberni in 1977–1978 showed 1–3% were Whistling Swans. Other records (BCPM) indicate that Whistling Swans are usually seen only on southern Vancouver Island. That may be because most observers are from the southern part of the island, or it may reflect the more southerly winter distribution of Whistling Swans (Bellrose 1976). If Whistling Swans were uniformly distributed a conservative estimate of their numbers would be 2% or 20 birds.

Cygnets accounted for 229 or 21.5% of the swans counted in this study. The proportions of cygnets reported by Smith and Blood (1972) ranged between 22% and 26%, which they suggested was indicative of an expanding population not yet limited in breeding habitat. Although productivity between years is variable (Table 1), factors other than availability of breeding habitat may be limiting the population. King (1976) reported a yearly breeding population growth of only 3.5%. Mortality may be high during the winter (J. King, personal communication) or during spring migration in order for the population to be expanding so slowly.

Major Concentrations

Large concentrations in 1977–1978 were at Nanaimo Harbour (58), Mitchell Lake (55), Nanaimo Lakes (24), Somenos Lake (28), Cowichan River estuary (35), Port Alberni (72), Sarita River estuary (53), Kelsey Bay (76), Northy Lake (91), and Comox Harbour (92). Areas of major use seem to have changed between surveys (Table 2). The largest decrease was at Holberg, from 60 in 1970–1971 to only 8 in 1977–1978, but no regular ground counts exist for that area; local movements may have affected the counts in one or more surveys.

TABLE 2—Numbers of swans wintering in areas reported to have large concentrations in previous surveys

Area	Number of swans		
	1969–71[1]	1972–73[2]	1977–78[3]
Kelsey Bay	140	129	76
Pt. Alberni	83	195	97
Kyuquot Sound	81	39	35
Tlupana Inlet	78	57	8
Comox Harbour	74	79	185(274)[4]
Holberg	50	37	8
Herbert Inlet	51	4	11
Nanaimo	51	48	151
Chewat River	48	45	28

[1]Smith and Blood (1972).
[2]Smith and Trethewey (unpublished data).
[3]This study.
[4]Maximum observed in weekly ground counts at Comox, 1977–1978.

The largest increases have been in the Comox and Nanaimo areas. Both locations have estuaries, but the major surrounding land use is agricultural. More swans were seen on adjacent farmland than on either estuary in this study. In both areas there has been a trend in the last 10 yr towards more intensive dairy farming. Consequently pastures are now planted with fast-growing grasses of high nutrient content. I believe the attractiveness of these pastures and their proximity to open water are the main reasons swans are concentrating in these areas. Although adjacent estuaries continue to be important when snow or frost keeps the swans off the pastures, conflicts with farmers seem inevitable, should swan use of pasture land continue to increase.

TABLE 3—Numbers of swans wintering in areas subject to frequent ground counts or regular Christmas Bird Counts

Date	Location			
	Comox[1]	Nanaimo[2]	Kelsey Bay[2]	Port Algerni[3]
1972–73	51	23	No data	No data
1973–74	56	14	98	No data
1974–75	144	28	83	No data
1975–76	No data	36	73	178
1976–77	No data	50	59	No data
1977–78	264	75	75	80

[1]Data from D. Trethewey (personal communication) and this study.
[2]Data from American Birds, Vol. 27–32.
[3]Data from Copland (1976, p. 212) for 1974–75, and this study in 1977–78.

Other data support my belief that swans may be relocating into certain areas (Table 3). Ground counts conducted by the Canadian Wildlife Service at Comox showed that peak counts have increased. Data from Christmas Bird Counts, while not as rigorous as the ground counts at Comox, show similar trends. Nanaimo also showed a general increase, while Kelsey Bay showed a decrease in swan use. Local British Columbia Fish and Wildlife Branch personnel also believe that these trends are real; the locations of major concentrations of swans are changing.

More research is needed to determine the habitat and food requirements of wintering swans. Alternative means of reducing swan use of pasture grasses, including lure crops and scaring, will also need study if such use increases.

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Interspecific Vocal Mimicry by Pine Grosbeaks

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Taylor, Peter. 1979. Interspecific vocal mimicry by Pine Grosbeaks. Canadian Field-Naturalist 93(4): 436–437.

Mimicry of the calls of the Hairy Woodpecker, Gray Jay, American Robin, and Redpoll (sp.) by adult male Pine Grosbeaks, during "whisper singing" on the species' winter range, is described.

Key Words: Pine Grosbeak; *Pinicola enucleator;* vocal mimicry.

This note describes vocal mimicry during "whisper singing" by adult male Pine Grosbeaks (*Pinicola enucleator*) on the species' winter range in southeastern Manitoba. Interspecific vocal mimicry has been reported for several bird species (e.g., Adkisson and Conner 1978; Armstrong 1973), but the only suggestion of such behavior by Pine Grosbeaks is a reference to four birds uttering "an amplified version of the common flight call of the goldfinch" (Bent 1968, p. 333). Soft, warbled "whisper singing" is docu-

mented for many North American fringillids including Pine Grosbeaks (Bent 1968).

At 09:00 on 26 February 1978 I noted several Pine Grosbeaks in Pinawa; three of these were uttering soft warbling songs. One adult male sang particularly softly, and interspersed the warbled phrases with realistic imitations of several other birds' calls, uttered clearly but softly. I approached within 5 m of the bird as it perched alone in a small aspen, so there is no doubt that it gave all the calls noted. These included the 'pic' call-note of a Hairy Woodpecker (*Picoides villosus*), the harsh 'kuk-kuk-chikkikik' call of a Gray Jay (*Perisoreus canadensis*), the clucking call and rattling alarm-cry of an American Robin (*Turdus migratorius*), and the call-note, with rising inflection, of a Redpoll (*Carduelis* sp.). Some slurred whistles were Starling-like (*Sturnus vulgaris*), but not unequivocally recognizable. A muted version of the Pine Grosbeak's own triple-noted flight call was also included.

These various calls were interjected, with no apparent ordered sequence, at intervals of about 3 s into the warbled song, and the medley was sustained for periods of 20 s or more. All of the imitations were not included in each bout of singing. The bird sang for about half of the observation period of about 15 min, and was still singing when I left.

At 11:30 on 5 March 1978 I heard what was presumably the same bird uttering similar vocalizations at the same location. The song was less sustained on this occasion, and interference from extraneous noise made observation difficult.

At 12:00 on 4 February 1979 I observed an adult male Pine Grosbeak uttering a "whisper song" while foraging in a spruce tree in Pinawa. This song continued, with one 15-s break, for about 6 min. It consisted of a variety of whistled and warbled phrases, and included imitations of American Robin and Hairy Woodpecker call-notes.

Although it is possible that the same individual Pine Grosbeak was involved in both the 1978 and 1979 records, the observation of this behavior in two winters does suggest that vocal mimicry may not be uncommon in Pine Grosbeaks. All of the birds imitated, except the American Robin, winter regularly in the Pinawa area. If the Pine Grosbeaks had wintered in southeast Manitoba, then they would have learned the robin calls the previous fall at the latest.

I thank Richard W. Knapton for helpful comments on this note.

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Influence of Weather on Aggression in Tree Swallows[1]

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Harris, Reid N. 1979. Influence of weather on aggression in Tree Swallows. Canadian Field-Naturalist 93(4): 437–438.

Cool foggy weather significantly reduced territorial aggression in a Tree Swallow (*Iridoprocne bicolor*) population in New Brunswick.

Key Words: aggression, weather, Tree Swallow, *Iridoprocne bicolor.*

Weather can influence the behavior of animals in nature. For example, Grubb (1978) and Travis (1977) have found that weather affected the daily and seasonal foraging habits of birds. This note reports on the effects of weather on territorial aggression in the Tree Swallow, *Iridoprocne bicolor.*

Study Site and Methods

From 17 May until 1 August 1978, I conducted a study of aggression, territoriality, and reproductive success in Tree Swallows on Kent Island, New Brunswick, Canada. Tree Swallows have nested in uniformly spaced man-made boxes in two open fields on Kent Island for 45 yr (Paynter 1954). In 1978, two

[1]This paper is a contribution from the Bowdoin Scientific Station, Kent Island, New Brunswick, Canada.

new spatial patterns were created by moving nest-boxes from their original 30-m uniform spacing, leaving 12 uniformly spaced boxes as a control comparable with previous years. The first spatial pattern consisted of alternating, at 30-m intervals, a pair of boxes, 1 m apart, with a single box. Twenty-eight boxes were arranged in this manner. The second pattern consisted of two replicates of a spiral arrangement of five boxes placed so that boxes were 1 m, 2 m, 4 m, and 8 m away from the central box. The two spirals were 30 m apart; also 30 m separated the nearest boxes of adjacent spatial patterns.

All breeding females and several breeding males were color-marked for individual recognition (see Hoogland and Sherman 1976). Adult Tree Swallow behavior was recorded for 4 wk, including the approximately 20-d nestling period of Tree Swallows on Kent Island (Paynter 1954; this study). Twenty-five occupied nest-boxes from all spatial patterns were selected at random (by drawing numbers from a hat) from a total of 36 active boxes for observation. Two or three active nest-boxes were watched simultaneously for 45-min periods. Each box was observed for about 7 h during the 4-wk observational study: a total of 182 h of observation was accumulated. Observations were conducted in all kinds of weather except driving rain from 09:00 to 14:30 Atlantic Daylight Time. Warm days (>12°C) with high visibility (>100 m) were classified as "weather 1" days. Cool days (≤12°C) with low visibility (>100 m; i.e., fog) were classified as "weather 2" days. All observational data fit into one of these categories: foggy days were always cool.

During observations, the amount of territorial aggression and the locations of territorial boundaries were carefully monitored. Fights were defined as two or more birds actually contacting one another in an aggressive territorial encounter. Chases were similar to fights, but lacked actual contact. All aggression occurred in the context of territorial defense of nest-boxes, i.e., marked and unmarked resident birds of both sexes excluded unmarked swallows from their territories throughout the nestling period.

Results and Discussion

Cool foggy weather significantly reduced territorial aggression in Tree Swallows (Table 1). One striking example of the influence of weather on aggression was observed on 11 July. From the beginning of observations at 09:00 until 10:00, cold foggy weather prevailed, and aggression was non-existent. At 10:00, a rapid clearing began. Concomitantly, swallows at the two active boxes being watched began defending their nest-boxes against unmarked intruders. Fifteen separate fights that involved actual contact between birds were observed between 10:10 and 10:30. Aggressive activity was directly associated with weather conditions.

TABLE 1—Aggression rates, mean ± SE of aggressive interactions per pair of Tree Swallows during a 45-min period, by weather are based on 182 box h. All 25 watched pairs were observed on weather 1 days, but only 19 pairs on weather 2 days

Aggression	Weather 1	Weather 2	P^1
Fights	2.0 ± 0.27	0.18 ± 0.16	<0.001
Chases	0.61 ± 0.28	0.11 ± 0.03	>0.05
Total	2.6 ± 0.43	0.29 ± 0.07	<0.001

[1] t-test; variances unequal.

The exact proximal causes of the reduction in aggression during cool foggy weather are unknown. Lowered visibility associated with fog, however, could interfere with the swallows' cues of individual recognition so that potential aggressors may not be recognized except at very close distances. Alternatively, during periods of low visibility, foraging for the same quantity of insects must have taken longer than foraging in clear weather. Under foggy conditions, and given a parental commitment to feed nestlings, most of the swallows' time would have been taken foraging. Whether these explanations can be distinguished or demonstrated is the subject for future work.

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Abandoned Windmill Used as a Nesting Site by Great Blue Herons

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DesGranges, Jean-Luc. 1979. Abandoned windmill used as a nesting site by Great Blue Herons. Canadian Field-Naturalist 93(4): 439–440.

An active Great Blue Heron (*Ardea herodias*) nest was discovered on the platform of an abandoned windmill at Batture aux Loups-Marins, Quebec. Among the hundred or so heronries known in Quebec, this was the only one where a man-made structure was used.

Un nid actif de Grand Héron (*Ardea herodias*) installé sur la plateforme d'une éolienne désaffectée a été découvert à la Batture aux Loups-Marins, Québec. Parmi la centaine de héronnières connues au Québec jusqu'à ce jour, c'est la première fois que l'on observe l'utilisation d'une structure artificielle par cette espèce.

Key Words: *Ardea herodias*, nesting platform.

On 25 April 1978, while conducting an aerial survey of aquatic bird colonies in the St. Lawrence estuary for the Canadian Wildlife Service, Pierre Dupuis and I discovered an active Great Blue Heron (*Ardea herodias*) nest on the platform of an abandoned windmill at Batture aux Loups-Marins (47°14′N, 70°25′W) (Figure 1). We located four other nests being built in a grove of tall willows (*Salix* sp.) in the vicinity of the windmill. There were no Great Blue Herons at this site prior to 1978 (Reed 1973; personal observation 1977).

On 1 June, the heronry contained eight active nests, four of which contained only eggs ($\bar{x} \pm SD = 3.0 \pm 1.6$) whereas the others, including the nest on the windmill, held both eggs and young. On 3 July, six nests remained, all with young herons ($\bar{x} \pm SD = 2.0 \pm 1.2$). The nest located on the windmill held four young herons whereas the others held fewer than three each.

Although Great Blue Herons have been recorded nesting on duck-hunting blinds (Stotts 1959) and navigational buoys (Henny 1978), it is nonetheless unusual for them to nest on artificial platforms. Among the hundred or so heronries known in Quebec, this was the only one in which a man-made structure was used (DesGranges, unpublished data). Nevertheless, other species of herons have been known to nest on artificial structures (McIlhenny 1934; Finkenstaedt and Heckenroth 1974; Wiese 1976). This suggests that the erection of elevated platforms where Great Blue Heron natural nest sites have been destroyed could prove to be an effective remedial technique, providing other features of the habitat remain suitable. At Batture aux Loups-Marins, the artificial platform was occupied from the time the heronry was first established and the nest found on it produced more young than any of the nests located in trees, the usual nesting site for this species.

I thank Transport Canada for making a helicopter available for our use in the St. Lawrence estuary survey.

FIGURE 1. Great Blue Heron nest built on platform of abandoned windmill.

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Unusually Late Pregnancy of a Muskrat in Southeastern New Brunswick

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Parker, G. R. 1979. Unusually late pregnancy of a Muskrat in southeastern New Brunswick. Canadian Field-Naturalist 93(4): 440–441.

A Muskrat (*Ondatra zibethicus zibethicus*) containing nine embryos was trapped on 6 November 1978 on the Tantramar marshes in southeastern New Brunswick. The projected birth date for the embryos was the last week of November. This is the latest reported pregnancy for a muskrat in eastern Canada.

Key Words: Muskrat, late pregnancy, New Brunswick, *Ondatra zibethicus zibethicus*.

As part of a study of Muskrats (*Ondatra zibethicus zibethicus*) on the Tintamarre National Wildlife Area, Westmorland County, New Brunswick, carcasses of Muskrats caught during the 1978 fall trapping season (4 November – 31 December) were examined for sex, age, productivity, and other morphological measurements. Productivity was measured by placental scar counts from macroscopically examined female uteri.

The uterus of one female caught on 6 November contained nine embryos; these averaged 5–7 mm in length and were believed to be approximately 10–14 d old. The normal gestation period for Muskrats in northeastern North America is 25–30 d (Errington 1963). This Muskrat would have given birth during the last week of November.

This Muskrat had been live-trapped and ear-tagged 2 August; it weighed 1000 g. When caught in November it weighed 1490 g. Its exact age is uncertain. When tagged in August, it was subjectively classified as an adult, based upon size and appearance. When examined in November the molar fluting was at bone line, which left the age of the animal in question. The uterus showed no other scars of earlier pregnancies.

It seems most reasonable that this Muskrat was born late in the autumn of 1977, and that possibly it too came from a fall litter. This would account for its adult appearance in August, the questionable age from molar fluting, the absence of previous breeding, and its substantial weight gain in late summer and fall.

The Tantramar marshes of the New Brunswick – Nova Scotia border region contain some of the best habitat for Muskrats in the Maritimes. Under favorable conditions, it seems reasonable that autumn or fall breeding may occasionally occur, and that some kits survive the winter to enter the next year's breeding population. Such late-born females, however, probably do not breed until late the following summer.

Muskrats may give birth during all months of the year in California (Dixon 1922), Louisiana (Svihla and Svihla 1931), and Texas (Lay 1945). Further north, in Maryland, breeding normally ceases by late October (Forbes 1942). Late litters have been reported in September from Wisconsin (Beer 1950), east Tennessee (Schacher and Pelton 1975), Connecticut (Smith and Jordan 1976), and Manitoba (McLeod and Bondar 1952), and in October from Idaho (Errington 1963). In New Brunswick (Dilworth 1967) and Prince Edward Island (Dibblee 1970) the latest observed litters were born in September. Errington suggested that it is quite possible litters might rarely be sired during winter in Iowa. This specimen from the Tantramar marshes of New Brunswick, however, is the first documented evidence of a November pregnancy of a Muskrat in eastern Canada.

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Lynx Movements and Habitat Use in Montana[1,2]

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Koehler, Gary M., Maurice G. Hornocker, and Howard S. Hash. 1979. Lynx movements and habitat use in Montana. Canadian Field-Naturalist 93(4): 441–442.

Movements of two Lynx (*Lynx canadensis*) were monitored by radio telemetry: an adult male for 7½ mo from March to October and an adult female during January. Home range area for the male, determined from 21 radio locations, was 36 km². Most locations were in densely stocked stands of Lodgepole Pine (*Pinus contorta*) resulting from the 1910 fires. Snowshoe Hares (*Lepus americanus*), their principle prey, were also most abundant in these stands.

Key Words: habitat, Lynx (*Lynx canadensis*), Snowshoe Hare (*Lepus americanus*), activity patterns.

Little is known about seasonal habitat use or home range size of Lynx (*Lynx canadensis*). Most previous studies used snow-tracking techniques (Saunders 1963; Nellis et al. 1972; Brand et al. 1976). Berrie (1973) used radio telemetry to determine home range size in Alaska. In conjunction with a Wolverine (*Gulo gulo*) study in northwest Montana, we monitored movements of two Lynx seasonally during 1977 by radio telemetry.

Methods

Twenty live-traps were set from January through April along 40 km of Forest Service trail. Traps, measuring 40 × 40 × 65 cm, were constructed of tubular steel frames, chain link fence sides, and sliding steel doors. Lynx were immobilized with ketamine hydrochloride ("Ketalar," Parke Davis) in dosages approximating 21 mg/kg body weight. Lynx were eartagged and tattooed in the lip and on the body under the foreleg, measured, evaluated for general physical condition, and fitted with collars containing radio transmitters. Radio signals were monitored from fixed-wing aircraft and the ground.

The relative abundance of Snowshoe Hares (*Lepus americanus*) in various forest types was obtained by counting the number of tracks crossed per kilometre of trail after fresh snowfall. To help differentiate tracks only those traveling to the west of the trail and spaced 3-m apart were recorded. A vegetative description of each section of trapline included dominant overstory species, age class, and relative density.

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[1]Contribution of the Idaho Cooperative Wildlife Research Unit; the United States Fish and Wildlife Service, the Idaho Department of Fish and Game, the University of Idaho, and the Wildlife Management Institute cooperating.

[2]University of Idaho College of Forestry, Wildlife and Range Sciences Publication No. 168.

TABLE 1—Relative abundance of Snowshoe Hare in four vegetative cover types along trapline during 14 d of survey

Vegetative cover	Stand age, yr	Stand density	Distance surveyed (km)	Tracks	
				Total no.	No. $km^{-1} \cdot d^{-1}$
Lodgepole Pine, pure stands	< 80	Dense	9.0	317	2.54
Grassland islands in dense Lodgepole Pine	< 80	Dense	3.2	96	2.15
Subalpine Fir–Englemann Spruce	Mature > 100	Medium	2.4	15	0.45
Islands of Lodgepole Pine, Douglas Fir, Ponderosa Pine (*Pinus ponderosa*) in grasslands	Mature > 100	Sparse	5.6	11	0.14

Results and Discussion

One adult male (weight 10 kg), one adult female (7 kg), and one juvenile female (4 kg) were captured. The juvenile accompanied the adult female and was not radio-collared because it was too small. The adult female was captured on 14 January and located 8 times prior to being found dead on 31 January. Death was believed due to predation by a Mountain Lion (*Felis concolor*). The male was captured on 10 March and located 21 times by 27 October.

Most locations for the male and female were in young densely stocked stands of Lodgepole Pine (*Pinus contorta*). Twenty-six of the 29 locations (90%) occurred in timbered areas burned in 1910 and the remainder occurred in mature Douglas Fir (*Pseudotsuga menziesii*) – Western Larch (*Larix occidentalis*) stringers along stream bottom within the 1910 burn. Of the locations burned in 1910, 23 (88%) occurred on xeric sites where Lodgepole Pine was dominant and 3 (12%) on mesic sites where Subalpine Fir (*Abies lasiocarpa*) and Englemann Spruce (*Picea englemannii*) were dominant. No locations occurred in open grassland or semi-open areas, 90% were in densely stocked stands, and 10% in medium-stocked stands.

The estimated home range size for the male was 36 km^2. This figure is similar to that found in other studies. Winter tracking in Newfoundland showed a home range size between 15.5 and 20.7 km^2 (Saunders 1963). In Alberta they were from 11.1 to 49.5 km^2 (Brand et al. 1976). In Alaska, Berrie (1973) found Lynx to range from 12.8 to 25.5 km^2.

Snowshoe Hares were most abundant in densely stocked stands of Lodgepole Pine (Table 1). Brand et al. (1976) and Adams (1959) found that hares were most abundant in dense stands. Winter ground tracking during this study and in Alberta (Brand et al. 1976) indicate that Lynx concentrate hunting activity within areas of high hare activity because hares are their main food (Brand et al. 1976) and 90% of Lynx radio locations were in these stands. Saunders (1963) found that Lynx activity and the location of the home range boundary coincided almost exactly with a tract of 10- to 20-yr-old growth timber.

Our data suggest that Lynx concentrate activity in areas of high Snowshoe Hare activity, particularly in young dense stands of Lodgepole Pine. Radio telemetry indicates that there is no change in range areas or habitat use throughout the seasons.

Acknowledgments

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Decline of Summering Bald Eagles in Central New Brunswick

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Stocek, R. F. 1979. Decline of summering Bald Eagles in central New Brunswick. Canadian Field-Naturalist 93(4): 443–445.

The numbers of Bald Eagles (*Haliaeetus leucocephalus*) that summer in central New Brunswick have decreased considerably. This reflects chiefly a decline in the proportion of immature birds.

Key Words: Bald Eagle, *Haliaeetus leucocephalus*, New Brunswick, abundance, age composition.

The Bald Eagle (*Haliaeetus leucocephalus*) in New Brunswick is listed as endangered under the provincial Endangered Species Act of 1976. It was considered an uncommon resident and transient by Squires (1976), who reported that numbers of the bird had decreased drastically; however, there do not appear to be any published accounts giving details of that decline. This paper describes the decrease in numbers and change in age composition of summering Bald Eagles in the lower St. John River basin and other parts of central New Brunswick (between 45°30′N and 47°00′N). The 104-km² French Lake district, west of Grand Lake, Queens County, and centered at 45°50′N, 66°17′W, is of particular interest here (Figure 1). It includes the shores of French, Indian, and Maquapit Lakes, the thoroughfare joining them, and Loders and Portobello Creeks in Sunbury County.

Although distributed over the entire province in the past, the resident Bald Eagle, *H. l. alascanus*, was never considered numerous (Moore 1928). More recently, banding returns suggested that most summering eagles belonged to the southern subspecies, *H. l. leucocephalus* (Squires 1952). Those birds, mostly immatures coming from Florida (Broley 1947), wandered into the Maritime region in April and May, and returned southward in August and September (Wright 1953). The wintering birds of the resident form apparently move inland from coastal areas in February and March (R. F. Stocek and P.A. Pearce, unpublished data), and return to the coast late in the fall (R. F. Stocek, unpublished data).

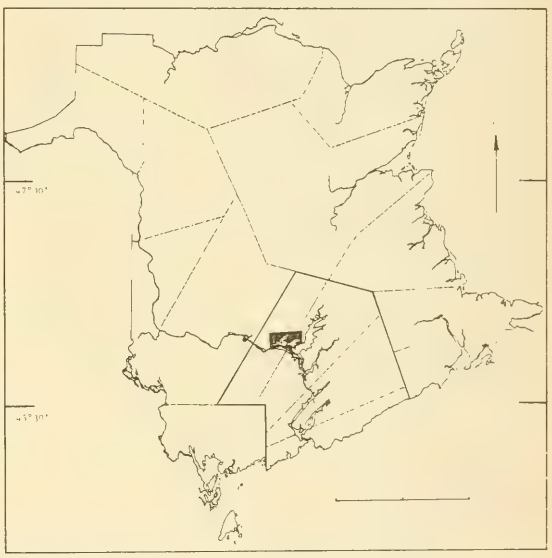

FIGURE 1. Map of New Brunswick showing the major areas mentioned in the text. The French Lake district, shown in dark shading, lies next to Grand Lake in Queens County. The lower St. John River extends downstream from Fredericton (the dark circle) and is shown enclosed by the solid outlines of the four basin counties. The central part of the province is defined by the marginal lines of latitude, 45°30′N and 47°00′N.

Methods

Bald Eagle records on file in the Northeastern Wildlife Station at the University of New Brunswick and at the New Brunswick Museum were compiled, with observations from the various naturalist clubs and provincial and federal resource agencies. Relatively few quantitative data were available prior to 1959 except for the French Lake district records of the Northeastern Wildlife Station, extending from 1949 to 1962. The French Lake sight records are treated separately, rather than being combined with the scattered data from the rest of the province, because so much more effort was spent on this relatively small area. Numerous low-level aerial flights (both fixed-wing and helicopter) were made over the lower St. John River basin during the spring and summer of 1974 and 1975. As used here, winter refers to December, January, and February; spring to March, April, and May; summer to June, July, and August, and fall to September, October, and November.

Results and Discussion

Cumulative sight records between 1959 and 1975 show that central New Brunswick accounted for 55% of the total spring observations and 60% of the summer observations of Bald Eagles in the province. Typically most of the eagles in this region were seen in the summer (38% of the area total) and spring (30%), and fewer in the winter and fall (22% and 10%, respectively).

Thirty years ago the basin of the lower St. John River was thought to be one of the most important summer habitats of *H. l. leucocephalus* in the northeast maritime region of the continent. The peak summer population of Bald Eagles in the French Lake district was estimated at 54 in 1949 and 45 in 1950 (Wright 1953). The Foshay Lake – Grimross Neck area 20 km to the southeast appeared to support a similar number in 1949. During those years a United States Fish and Wildlife Service aerial survey team saw more eagles in this area than in all the rest of the maritime provinces. Practically all the eagles counted in New Brunswick were seen here, with as many as 18 in the air at one time near French Lake. A total population of at least 100 eagles summering in the lower St. John River basin was suggested (B. S. Wright, unpublished data). Large numbers of summering eagles had also been reported there in May and June, 1937 to 1944, especially along Portobello Creek and from Fredericton to Jemseg (H. S. Peters, unpublished data). During the 1930s and 1940s, it was not uncommon to see 20–30 eagles in a day on the waterfowl breeding grounds in central New Brunswick (Squires 1976).

The mean numbers of summering eagles seen in the French Lake district declined during the 1950s and early 1960s. According to data from the Northeastern Wildlife Station, 2.3 birds were seen per successful day* during June–July, 1953–1954. By 1961–1962 this figure was down to 1.3; eagles then were being seen only infrequently by station personnel. B.S. Wright (personal communication), who had studied waterfowl in the St. John swamps and marshes since 1945, believed that there were no more than 10 eagles on the entire area in the summer of 1964. On 1 August 1974, I surveyed by helicopter 125 km of shoreline in the French Lake district and another 179 km of adjacent Grand Lake and Jemseg River; no Bald Eagles were seen. A provincial naturalist conducting a group canoe trip through the district and the nearby Oromocto River drainage reported that only one eagle was seen during the 192-km trip in mid-July 1974. The only eagles I saw during the many flights I made through the French Lake area in 1974 and 1975 were the one pair nesting there.

The decrease of Bald Eagles in certain parts of North America has been accompanied by a decline in the proportion of immature birds in those populations (Sprunt 1969). The percentage of immatures in the French Lake district summering population for 1953 to 1962 is shown in Table 1. The influx of wandering birds probably accounted for the high May values, while birds leaving the area in August reduced the number seen. B. S. Wright (unpublished data), reported a high 1:4 adult to immature ratio for the district during the spring-summer period in 1949.

TABLE 1—The monthly distribution of immature Bald Eagles in the French Lake district of New Brunswick from 1953 to 1962, expressed as a percent of the total known-age birds seen

Month	% Immature	Total no. seen
May	44	41
June	23	73
July	21	70
August	10	19

By 1953–1962 the ratio had changed to 4:1. Values of 30% immatures recorded in 1953–1954 and 13% in 1961–1962 suggested a decline during that period. Although data are fragmentary for the intervening years, June and July sightings provide some insight. From 1953 to 1956, 25% of the 79 eagles seen in the district were immatures. Station personnel reported 19% immature birds (of 64 seen) from 1959 to 1962. New Brunswick sight records show that, in the province as a whole, but excluding data from the French Lake area, the proportion of immature eagles seen in spring and summer decreased from an average of 32% during 1967–1973 to 22% in 1974–1975 (Table 2). These comparative seasonal values very likely reflect a real difference between the two time periods, because the increased effort in 1974–1975

TABLE 2— The seasonal distribution of immature Bald Eagles in New Brunswick from 1967 to 1973 and 1974–1975, expressed as a percent of the total known-age birds seen (in parentheses). French Lake district statistics are not included here

Season	% Immature, 1967–1973	% Immature, 1974–1975
Winter	20 (56)	20 (35)
Spring	25 (76)	14 (50)
Summer	37 (104)	27 (93)
Fall	22 (49)	20 (25)

*A day on which at least one eagle was sighted; unfortunately statistics on total effort (days) are not available.

would have been expected to reveal a greater rather than a smaller proportion of the less conspicuous immature birds.

The decline in the summering population of Bald Eagles in central New Brunswick and probably throughout the province was to be expected. The decrease in Bald Eagle reproduction in other regions of North America during the last two decades is also well documented (e.g., Sprunt 1969; Sprunt et al. 1973). Both Broley (1950, 1958) and Howell (1958) reported increasing nest failures in Florida, which was an important source of birds summering in the Maritimes.

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Lesser Black-backed Gull, *Larus fuscus*, in Labrador Waters

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Powers, Kevin D. 1979. Lesser Black-backed Gull, *Larus fuscus*, in Labrador waters. Canadian Field-Naturalist 93(4): 445–446.

An adult Lesser Black-backed Gull, *Larus fuscus*, sighted 140 km E of Nain, Labrador, adds to evidence that the species occurs in small numbers through eastern North American waters.

Key Words: Lesser Black-backed Gull, *Larus fuscus*, Labrador.

On 21 July 1978 I observed an adult Lesser Black-backed Gull (*Larus fuscus*) from the *CCGS Narwhal* at 57°11′N, 59°20′W approximately 140 km ENE of Nain in the Labrador Sea. Sightings of Lesser Black-backed Gulls include Greenland: Godthåb (ca. 64°30′N) and Godhavn (69°20′W) (Salomonsen 1967); at sea 100 to 675 km SSE of Cape Farewell, Greenland (ca. 54°30′N to 60°00′N) (Brown 1968); Northwest Territories (cf., American Birds 1978, 32: 1186; Alsop and Jones 1973); Churchill, Manitoba (Ross and Cooke 1969); Grand Banks (Brown et al. 1975); Nova Scotia (cf., Nova Scotia Bird Society Newsletter 1977, 19: 100; E. L. Mills, unpublished data); and northeastern United States (W. R. Petersen, unpublished manuscript; Bull 1964; K. D. Powers, unpublished data).

The gull approached the ship from astern at 16:40 EST and "ship followed" for 55 min before departing. It did not appear to be associated with any other species in the area. The winds were WNW at 25 knots, and seas were 1–2 m. The skies were overcast with no precipitation. The bird was observed with 8×40 binoculars in good light within 50 m of the ship. All distinguishing field marks of the species were seen,

including the bright yellow legs and feet. The mantle was slate-gray becoming black in the outermost primaries, suggesting *L. f. graellsii*. A color photograph was obtained showing the mantle color pattern of the bird.

The sighting is the first record of Lesser Black-backed Gull for Labrador waters, and it adds to evidence of increasing regularity off eastern North America of the subspecies *L. f. graellsii*, which breeds in Iceland, Faeroe Islands, the British Isles, and Brittany (Witherby et al. 1941). The new record is only about 2000 km distant from Iceland, well within the range of sightings along American coasts from Davis Strait to Cape Hatteras.

I express my appreciation to R. G. B. Brown, W. R. Petersen, and T. Lloyd-Evans who helped to improve this note. R. G. B. Brown of the Canadian Wildlife Service arranged my passage aboard the *CCGS Narwhal*, and traveling expenses. I am also grateful to the United States Department of Energy (DOE Contract No. EE-78-S-02-4706) for support.

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Occurrences of the Red Phalarope in the Prairie Provinces and Adjacent States[1]

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Goossen, J. Paul and Daniel G. Busby. 1979. Occurrences of the Red Phalarope in the prairie provinces and adjacent states. Canadian Field-Naturalist 93(4): 446–449.

Twenty-six records of Red Phalaropes (*Phalaropus fulicarius*) were obtained for the prairie provinces and adjacent states. It is suggested that the predominance of fall records in western Alberta and Montana is due to the guiding influence of the Rocky Mountains for southbound and southwestbound birds, and that the scattered spring records result from the lack of such an influence for northbound birds. It remains possible that the initial displacement from the normal migration route is caused by adverse weather conditions.

Key Words: Red Phalarope, *Phalaropus fulicarius*, extralimital sightings.

Our interest in the Red Phalarope (*Phalaropus fulicarius*) was aroused when we observed a female in alternate plumage in the Assiniboine River Diversion about 3 km south of Lake Manitoba and 5 km west of Delta, Manitoba (50°11′N, 98°19′W). This was the third sighting in southern Manitoba; the species is considered a rare spring migrant in the Churchill region (Jehl and Smith 1970).

The Red Phalarope breeds along the coasts and islands of northern Asia, Europe, and North America. It winters primarily in the southern hemisphere off the coasts of South America and western Africa (Godfrey 1966). In North America, it migrates along both the Atlantic and Pacific coasts (American Ornithologists' Union 1957; Godfrey 1966). This note summarizes and discusses Red Phalarope records from the Canadian provinces of Manitoba, Saskatchewan, and Alberta, and from the adjacent states of Montana, North Dakota, and Minnesota.

Twenty-six records of the Red Phalarope in the area under consideration are summarized in Table 1.

[1]This is paper number 74 of the University of Manitoba Field Station (Delta Marsh).

TABLE 1—Red Phalarope sightings for the prairie provinces and adjacent north-central states

Location	Date	No.	Source
Manitoba			
East Shoal Lake	12 October 1963	1	K. Gardner
Delta Marsh	19 June 1969	1	R. E. Jones
Delta Marsh	30 June 1975	1	This paper
Saskatchewan			
Long Lake[1]	July 1879	1	Macoun and Macoun (1909)
Old Wives Lake[2]	May 1895	1	Macoun and Macoun (1909)
Sandfly Lake	11 June 1914	1	Mitchell (1924)
Proctors Lake	21 May 1946	1♀	Mowat (1946)
Alberta			
Didsbury	3 September 1903	1	Salt and Wilk (1966)
Beaverhills Lake	September 1925	1	Salt and Wilk (1966)
North Saskatchewan River near Graveyards Cabin	23 May 1953	4♀	Banfield (1954)
Pigeon Lake	13 July 1960	1♀	Salt and Wilk (1966)
Carseland Dam[3]	23 October 1966	1	Smith and Klauke (1967)
Cochrane Lake[3]	30 October 1966	1	Smith and Klauke (1967)
Big Lake	11 November 1975	1	Ebel (1976)
Stirling	—	—	Godfrey (1966)
Montana			
Bowdoin National Wildlife Refuge	July 1953	1	P. D. Skaar
Harrison Lake	26 August 1959	1	Rogers (1960)
Harrison Lake	3 November 1963	1	Rogers (1964)
Harrison Lake	11 October 1970	1	Rogers (1971)
Freezeout Lake	17 August 1976	1♀	Serr (1977)
North Dakota			
Cando[4]	23 May 1890	1	Stewart (1971)
Slade National Wildlife Refuge	25 July 1963	1	Stewart (1971)
Minnesota			
Knife River Lake	17 November 1963	1	Hofslund (1964)
Mille Lacs Lake	29 October 1976	1	Savaloja (1977)
Mille Lacs Lake	19 November 1977	1	Harding (1978)
Moorhead	27 May 1977	1	Wachtler and Wachtler (1977): Anderson (1977)

[1]Now called Last Mountain Lake.
[2]Now called Johnstone Lake.
[3]Validity of sighting questioned by Sadler and Myres (1976).
[4]Considered as hypothetical by Stewart (1971).

seven are of females; the others were not sexed. We grouped the 25 observations with dates into three periods: spring (April–June), midsummer (July), and fall (August–November), and plotted them (Figure 1). Two patterns are noticeable. First, seven of the eight spring records and three of the four midsummer records are scattered east of 110° W. Second, 9 of the 13 fall records are from the extreme western part of the area, on or near the eastern slope of the Rocky Mountains.

No correlation with weather could be established for the Canadian sightings of Red Phalaropes and P. D. Skaar (personal communication) noticed no unusual weather conditions associated with the Montana sightings. The spring record for Minnesota, however, was preceded by periods of thunderstorms and unsettled weather with 35 to 40-km south winds.

The known eastern spring migration route follows the Atlantic Ocean to the arctic breeding grounds. Observations of Red Phalarope in southern Ontario (W. E. Godfrey, personal communication), however, suggest that some of these birds may pass through the Great Lakes and Hudson Bay, using a similar short-cut to that suggested for Arctic Terns (*Sterna paradisaea*) (Godfrey 1973) and Sabine's Gull (*Xema sabini*) (Lambert 1973). The scattered spring migrants reported on the Great Plains may be phalaropes attempting to migrate overland. Oldsquaw (*Clangula hyemalis*), also a northern breeder, regularly pass through southern Manitoba in both spring and fall (Sexton and Collins 1977), and the possibility of an overland migration route for another arctic breeder,

FIGURE 1. Red Phalarope sightings for the prairie provinces and adjacent north-central states. Open circles, spring records; half-filled circles, midsummer records; closed circles, fall records.

the Long-tailed Jaeger (*Stercorarius longicaudus*), has also been suggested (Jehl and Smith 1970).

The numerous fall records in Alberta and Montana suggest that some migrants proceed southward or southwestward until they encounter the Rocky Mountains. With reference to the Montana observations, P. D. Skaar suggested that a prolonged Pacific air flow might have deterred the birds from crossing the mountain range (Rogers 1964), which thus served as a leading line. No such guiding influence would be available for northbound birds, which are much more scattered. The fall sightings from Manitoba and Minnesota may be migrants from the Hudson Bay – Great Lakes route.

Two of the fall birds were listed as females in Table 1; however, we suggest that generally these are young of the year having no previous migratory experience. Of 18 casual records presented by Bent (1927) for interior Canada and United States, 16 were fall records and one was not dated. This further suggests that dispersal of the young may account for many of the interior records. It seems possible that adverse weather conditions are the initial displacement factor for these extralimital sightings, but that after displacement the birds attempt the usual southward or northward orientation, which leads some of them overland.

Despite the periodic, infrequent sightings of Red Phalaropes over the prairie provinces and adjacent states, such records constitute an extremely small fraction of the total migration of the species. It is unlikely that enough of these birds survive for selection in favor of a regular inland migration to occur.

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Nesting of the Calliope Hummingbird in Kananaskis Provincial Park, Alberta

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Brunton, D. F., S. Andrews, and D. G. Paton. 1979. Nesting of the Calliope Hummingbird in Kananaskis Provincial Park, Alberta. Canadian Field-Naturalist 93(4): 449–451.

A nest of Calliope Hummingbirds (*Stellula calliope*) was studied in Kananaskis Provincial Park, Alberta, in 1977 and 1978. Incubation period (16 d) and nestling period (18–21 d) were determined. The nest was constructed in precisely the same location in successive years and nest construction was completed during incubation. These unusual nesting characteristics may be adaptations to severe environmental constraints at high elevations near the northern limit of the species' range.

Key Words: Calliope Hummingbird, *Stellula calliope*, incubation period, nestling period, nest construction, nest site selection, Alberta.

A nest of the Calliope Hummingbird (*Stellula calliope*) was discovered in Kananaskis Provincial Park, Alberta, in mid-June 1977. This bird is found only locally in Alberta (Salt and Salt 1976). A second nesting was discovered at the same site in 1978. The following discussion deals with the results of our observations for both years.

Observations

The nest was situated on a horizontal limb of a Lodgepole Pine (*Pinus contorta*) at the base of a steep shale creek bank. It was 1 km south of the "Church Camp" on the east bank of Pocaterra Creek (50°41′N, 115°5′W) at an elevation of 1660 m. The nest was a tiny cup constructed of lichen fragments and fine plant materials.

The 1978 nest was constructed on the weathered remains of the 1977 nest; beneath the latter were the remains of one or more previous nests (Figure 1). In 1978 the nest was first observed on 10 June as the first egg was being laid. The nest at that time was a shallow cup with poorly defined walls and an unlined bottom. At 11:45 the bird was observed frequently poking and prodding the edges of the nest and pulling material in towards the center. For about 2 min it performed an action we described as "running on the spot" — apparently deepening the cup in preparation for egg-laying. The bird subsequently became very still on the nest for several minutes and then flew off. A single, pinkish-white translucent egg was subsequently found in the nest. We believe the egg was laid as we were watching the bird. On 13 June the nest contained one dull-white, opaque egg and one (freshly laid) pinkish-white, translucent egg. Although the first egg was laid on the bare floor of the nest, both were now nestled into a bed of feathers in a deep high-walled cup. The increased size and depth of the nest was quite striking. By 29 June the nest was larger yet, with substantially thickened wall. The two-egg clutch of the 1978 nest was completed on 13 June when we observed it at 16:20. On 29 June at 17:30 two tiny young were observed, one still wet and lying on fragments of the egg from which it had just hatched. The other young was dry. Incubation had taken 16 d. The nestling period ran from 3 July to 21 July (18 d) in 1977 and 29 June to 20 July (21 d) in 1978.

On 20 July 1978 we observed the departure of the young from the nest. One of the young was out of the nest but still in the nest tree when observations began. In approximately 20 min, the remaining nestling

FIGURE 1. Adult (female) Calliope Hummingbird on nest in Kananaskis Park, Alberta. Note remains of previous nest under active nest; the 1978 nest was situated on the remains of this one. Photographed on 23 June 1977 by D. G. Paton.

moved to the lip of the nest, made its first flight, and ultimately moved 4 m away. The female adult returned to the nest tree four times to feed or preen the young birds during the observation period.

The adult (only the female was seen in both years) usually approached the nest from the creek side of the tree, perching near the top of the nest tree and then working down through it in three or four short flights. The bird used the same perches each time. Calliope Hummingbirds also exhibited a set pattern of manoeuvers to approach a feeder at Bow Valley Provincial Park, Alberta, and when disturbed the birds would flee to precisely the same perch in a nearby Lodgepole Pine (B. Romanyshyn, personal communication).

During the early stages of incubation (up to approximately 10 to 12 d), the adult would leave the nest when observers approached within 10 m. During late incubation and when young were in the nest, however, the adult would allow the observers to approach within 1 m of the nest before flying off. When it was flushed during this latter period, the bird would aggressively "buzz" the observers (usually positioned 3 to 5 m from the nest). The bird would often approach to within 30 to 50 cm of the observers during this aggressive behavior.

Discussion

There is no published literature on the nesting of Calliope Hummingbird in Canada with which we can compare our observations. Calder (1971) cites 21 to 23 d for the nestling period in Wyoming and this compares well to a figure of 21 d for a nest at Hood River, Oregon (on file with the North American Nest Record Scheme).

Figure 2 indicates the timing of egg and young observations from cards on file with the British Columbia Nest Record Scheme. None of the British Columbia cards recorded a complete incubation or nestling period observation. By summing the total of days in which young or eggs were in these nests and placing these data in quarter-month periods, the nesting chronology of the Calliope Hummingbird in British Columbia is illustrated. The total nesting period is roughly 37 d. The difference between starts of young and egg peaks is about 15 d. The dates for Kananaskis Park in 1977 and 1978 agree well with the peak of observations of eggs and young in nests in British Columbia. The sample of British Columbia records was too small to subdivide by latitude and/or elevation. When sufficient numbers of observers are filed, this would certainly be worthwhile.

The total length of the nesting period for Calliope Hummingbird is approximately 34 to 38 d in northwestern North America (Calder 1971; this study). There is some suggestion that the period is shorter at the northern limit of the species range (34–37 d in Kananaskis vs. 36–38 d in Wyoming).

We strongly suspect that the same female was responsible for the 1977 and 1978 nestings in Kananaskis Park. As the bird was not banded, we cannot be certain of this. In any case, the use of precisely the same site in successive years is apparently atypical in hummingbirds. W. Ray Salt (personal communication) observed this practice with Rufous Hummingbirds (*Selasphorus rufus*) in the 1960s in British Columbia, and has a nest collected by J. Grant of Vernon, British Columbia, which was used in 1938 and again in 1939. Pearson (1953) notes repeated use of nests by the Estella Hummingbird (*Oreotrochilus estella*) in high mountain caves in the Peruvian Andes. He indicates, however, that these nests are "reconditioned" each year; the Calliope Hummingbird nests we observed were completely rebuilt upon the previous year's remains. We found no published reports of nests being completed during the period of egg laying, although Skutch (1951) does report

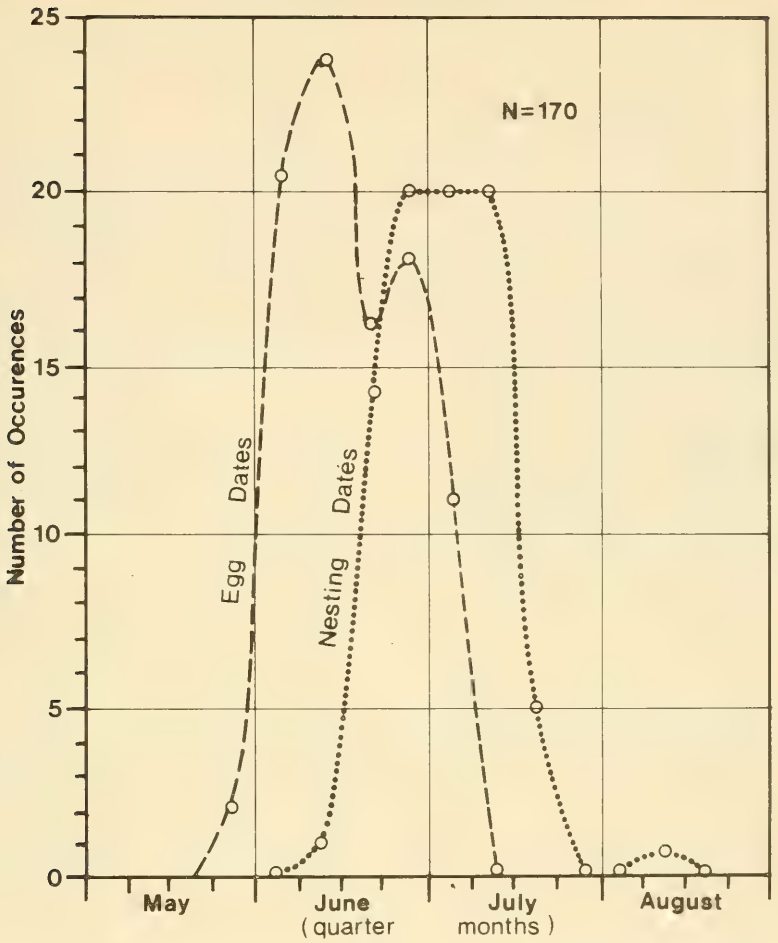

FIGURE 2. Frequency of occurrence of eggs and young in nests of the Calliope Hummingbird in British Columbia.

renewal of some nesting material during incubation by some tropical hummingbirds.

The utilization of the same nest site for a succession of years, completion of nest construction during incubation, and the possibly shorter nesting period of the species in this area may be adaptations to near-marginal breeding conditions in Alberta at the northern limit of its range.

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News and Comment

FON Conservation Award for *The Canadian Field-Naturalist*

A Federation of Ontario Naturalists (FON) Conservation Award has been presented to The Ottawa Field-Naturalists' Club in recognition of its outstanding contribution to the cause of conservation. The citation for the FON Award read as follows:

> "for the continued excellence of the journal *The Canadian Field-Naturalist* which has a well deserved national and international reputation and which provides a vital forum for reports on natural history and the environment by amateur and professional observers alike."

The FON Conservation Award was accepted by Dr. Lorraine C. Smith, Editor of *The Canadian Field-Naturalist*, at the Federation of Ontario Naturalists Conference at Toronto, Ontario on 5 May 1979. Dr. Peter A. Peach, President of the FON expressed the appreciation of all FON members for the continued excellence of the journal and personally congratulated the Editor. Mike Singleton, General Manager of the FON, added his congratulations and commendation to those of the Awards Committee, FON Directors, and participants at the annual conference and pointed out that the award in recognition of *The Canadian Field-Naturalist* was well earned. Moreover, he wrote: "It seems to me that we do not often enough recognize the great contribution the Ottawa club has made through this journal in facilitating natural history reports by amateur and professional alike, and most importantly in stimulating research by amateurs across the country." He asked that the commendation and congratulations be drawn to the particular attention of all members of The Ottawa Field-Naturalists' Club.

Notice of The Ottawa Field-Naturalists' Club Annual Business Meeting

The 101st Annual Business Meeting of The Ottawa Field-Naturalists' Club will be held in the auditorium of the National Museum of Natural Sciences, Metcalfe and MacLeod, on Tuesday, 15 January 1980, at 8:00 p.m.

Diana R. Laubitz,
Recording Secretary

Book Reviews

ZOOLOGY

Guide to the Study of Animal Populations

By James T. Tanner. 1978. University of Tennessee Press, Knoxville. 186 pp. U.S. $8.95.

Many of the mathematical and statistical techniques applied to the study of animal populations elude all but a specialist in the field. Therefore, I was somewhat elated to discover that this book is comprehensible to an average biologist having some experience in biometrics.

The book contains ten chapters describing a variety of techniques for studying animal populations. Subjects such as Density and Dispersion, Mark-Recapture Methods, Sex and Age Composition, Mortality and Survival, Reproduction, Migration and Recruitment are presented. Considerable discussion is devoted to mathematical relationships between population characteristics and methods of predicting population changes.

As the title suggests, all examples given deal with animal populations and many deal with big game species. Several problems are worked out in each chapter and suggestions are given for the arrangement of the raw data. These examples do much to dispel the mystique of seemingly incomprehensible formulae. Symbols are used as consistently as possible throughout the text and a list is provided at the beginning of the book.

The book is replete with references to more detailed discussions of various subjects and methodologies available in the literature. Moreover, the text is conveniently cross-referenced from chapter to chapter, enabling the reader to refresh his memory quickly from previous presentations on a topic.

One of the most interesting chapters discusses mark-recapture methods for measuring population characteristics. This is a very practical presentation and provides valuable insight into research design compatible with statistical analysis of the data.

The publication is intended for use by graduate students and field biologists. I am certain that it could be a very useful addition to any biological bookshelf. The straightforward presentation and numerous examples bolster the reader's confidence that he can apply statistical methodologies and techniques competently and that studies of animal populations need not be a mathematical maze. The author's candid critiques of techniques are valuable. Also, the list of literature citations is a useful tool for non-specialists wishing to delve further into some aspect of population studies.

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Quaternary Vertebrate Faunas of Canada and Alaska and Their Suggested Chronological Sequence

By C. R. Harington. 1978. Syllogeus Number 15. National Museums of Canada, Ottawa. 105 pp., 15 illus. Available from Library of National Museum of Natural Science, Ottawa K1A 0M8.

Most natural historians working with recent faunas are not especially familiar with the literature dealing with Pleistocene faunas and natural history. This is understandable, considering the present volume of literature dealing strictly with modern faunas. Anyone working with modern groups, however, can appreciate the historical perspective provided by the paleontological literature, especially that of the Pleistocene. Often this historical perspective provides insight into modern animal and plant distributions and geographic patterns as well as an understanding of changes in their geography in response to changes in ancient drainage patterns or patterns of glaciation.

A good synoptic review serves two functions. First, it provides a broad generalized background on a subject. Secondly it introduces the nonspecialist to the literature dealing with that subject. With regard to the Pleistocene faunas of Canada, Harington's paper successfully fulfills both objectives.

The information is presented in a concise, straightforward manner that makes data retrieval simple. The faunas are listed for each province and Alaska. Each section opens with a narrative concerning various fossil discoveries and their significance with regard to understanding Pleistocene events in the province. Both marine and terrestrial vertebrates are described. There is a good balance in the text between descriptions of the history of collecting, outstanding specimens that have been found, and the type of information that these finds provide. Following the

opening narrative of each section the Pleistocene faunas of specific provincial localities are listed. It is at this point that the paper becomes a reference work. Each faunal description begins with the fauna's location. The locality information varies in detail from the very general such as "Hand Hills, Alberta near Delia," to the very specific: "Acasta Lake, Northwest Territories (65°24′N, 115°31′W)." The locality description is followed by a faunal list which includes all known vertebrates from the site. This part alone will be of use to anyone interested in determining the Pleistocene distribution of a particular species. The mammals are well covered; the birds, reptiles, amphibians and fish are not as complete, but this is a reflection of the state of the art and the availability of specimens. It points out sharply the areas where more research is needed. Each faunal list is followed by a suggested age for the locality. Radiocarbon dates are included when available. The last part of each faunal description, entitled "Remarks" includes a diverse amount of information, such as descriptions of the bone deposits, environment of deposition, interpretation of habitat and the first occurrences of particular species. Finally, there is a listing of references for that particular fauna.

The paper has sixteen illustrations. One is a map showing the location of all the faunas discussed, one is a chart with the suggested chronological sequence of the faunas, three are artistic reconstructions of specific Pleistocene vertebrates, and eleven are photographs of specimens. All of the photographs occupy a full page. The map could have been a little larger as the amount of reduction tends to make reading the numbers of the localities difficult, but with a little squinting they can be deduced.

The final discussion and summary places the entire history of the Pleistocene of Canada in perspective. It discusses chronologically first appearances, migrations, changing environments and their significances with regard to changes in the fauna. The reference section has plenty of citations, which will permit anyone interested to pursue a particular subject further. The appendix contains a listing of nine faunas from northeastern Siberia for comparison with those from Canada and Alaska. This section is of interest since the faunal lists include species that did not manage to cross the Bering Straits into North America.

This well-ordered, concise review will make a handy starting point for anyone who wishes to obtain an overall view of the Pleistocene in Canada and Alaska.

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Birds of Man's World

By Derek Goodwin. 1978. British Museum (Natural History) and Cornell University Press, London and Ithaca. viii + 193 pp., illus. U.S. $10.95.

Although the title may suggest to some another "gloom and doom" volume on Man's destruction of wildlife, the subject matter concerns the ability and inability of birds to adjust to human environmental changes. Through a series of examples, Goodwin illustrates how the natural habits of various species suit them for adapting to, and thriving in Man's world, while those of other species doom them to extinction. This book appears to be written primarily for the layman, but as pointed out by D. W. Snow in the foreword, it also contains much of value to the professional ornithologist.

The majority of Goodwin's examples are European, with considerable emphasis on personal experience; however, other continents are not neglected, with many examples coming from the literature. Unfortunately, the sources are rarely given, and then usually vaguely. Thus, the serious student who wishes to pursue a topic in greater depth has little help in locating original material.

In his introduction, Goodwin points out that his book is not intended as a thorough review covering all aspects of Man's interactions with birds. The six numbered chapters cover various aspects of this topic as outlined below. The text is chatty and non-quantitative but written well and apparently free of printing errors. Several photographs and line illustrations by Robin Prytherch enhance the book, although neither are of exceptional quality.

Chapter 1, "Man and the environment," is concerned with the effects on birds of habitat alteration. These include obvious direct effects, such as destruction of habitat for some species, and expansion of habitat for others. Indirect effects are also discussed. For example, although many species benefit from the provision of artificial nest sites, the increase in aggressive hole-nesters such as Starlings could result in a decrease in less aggressive hole-nesting species. Although not intended as a complete review, this chapter seems comprehensive, with a few minor omissions. A long discussion about birds coming to

drink at artificial watering-holes in desert areas might well have mentioned the large number of recent occurrences of marine birds far inland at large reservoirs in the southern USA. I found Goodwin's discussion of Purple Martins and Tree Swallows misleading. After mentioning the benefit to the martins of numerous houses built for them, Goodwin notes that Tree Swallows have also been incidental beneficiaries by using nest boxes which have not attracted martins. This is true, but surely the Tree Swallow has benefitted far more from the extensive bluebird house programs in the prairie provinces and other parts of North America. The appearance of hybird bluebirds and swallows during range expansions caused by the provision of artificial sites is also omitted.

Chapter 2, "Birds in towns," consists of a comparison of major cities in various parts of the world in relation to their avifauna. Interactions of human behavior and bird behavior are shown to determine both the extent birds will live in cities and which species will do so under various circumstances.

Chapter 3, "Birds fed by Man," includes discussion of birds as pests, birds as scavengers on garbage, and deliberate feeding of birds by people. As in other chapters, Goodwin emphasizes the natural behavior of species as it adapts them to respond to food provided by Man intentionally or otherwise. Missing from the discussion of birds in crops are cases of birds saving crops, such as California Gulls in Utah and Franklin's Gulls in Manitoba. This chapter overlaps to some extend both chapters 2 and 5.

Introduced birds on all continents form the subject matter of chapter 4. After pointing out that most species that do well on being introduced into a new place are species that did well in their places of origin, where they were frequently somewhat of a pest, Goodwin reviews the success and failure of various introductions, and comments on factors which may determine rate of success. This chapter is slightly outdated for North America: the House Finch now inhabits much more of the East than indicated; the Skylark has spread to the San Juan islands of Washington (at least temporarily), and the predicted action to control the Monk Parakeet in the USA has taken place. I was also surprised to find only brief mention of the Black Swan of New Zealand with no reference to its adverse effects on native waterfowl there.

In chapter 5, Goodwin compares several species as to their habit of eating an unnatural food — bread. He ponders how each might come to recognize bread as food, how each behaves in obtaining and eating bread, and how much competition for bread among species takes place.

In his final chapter, Goodwin offers a cautiously optimistic outlook on the future. A list of scientific names of birds discussed includes page numbers, and thus also serves as a species index.

I recommend this book as a highly readable essay on an important topic.

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Statistical Inference from Band Recovery Data: a handbook

By C. Brownie, D. R. Anderson, K. P. Burnham, and D. S. Robson. 1978. Resource Publication Number 131, U.S. Fish and Wildlife Service, Washington, D.C. No price given.

Many workers with fish, mammals and birds have need of mark-recapture estimation techniques for assessment of population sizes and mortality rates. It is not that better estimates are provided by such techniques, but rather that direct sampling of concealed and highly mobile populations is impossible. Given the need for them, mark-recapture methods have evolved to levels of sophistication that would greatly impress early workers in the area. This handbook represents the latest state of the art, reflecting several decades of improvements in two areas: precision and accuracy.

Students encountering the simplest mark-recapture methods for the first time tend to react with shock at the low precision (i.e., wide confidence intervals) of their estimates, and often are convinced that they must have made a mistake in their calculations. The methods also tend to be vulnerable to biases in estimation caused by failure of assumptions, and such biases result in low accuracy. Methods such as those presented in this book improve precision by using data from repeated marking and capturing over a long series of time intervals (usually years), and they deal with biases by presenting a hierarchical series of models which differ from each other in their assumptions about the parameters of the populations being estimated. The authors emphasize that results are still dependent on assumptions for any particular model, but this approach allows sequential testing of the validity of various assumptions, which leads to

selection of the model satisfying the conditions with which the researcher is dealing.

Although the authors hope they have produced "a simple, easy-to-read primer," have emphasized examples from real data, and have put some of the mathematics in appendices, this handbook is not for the beginner. Differential calculus and two or three courses in applied statistics are assumed, and anyone without prior knowledge of the basic principles of mark-recapture methods is advised to start with the treatment of this subject in a general quantitative ecology text. For the professional working on wild populations that can not be assessed directly, however, this handbook will be a necessary addition to his library. The discussion and examples are in terms of bird-banding studies, but the models are generally applicable. Equal time intervals and recovery of dead animals (marked or unmarked) are assumed, with some discussion of unequal intervals and of capture and release of live animals. All methods described are related to FORTRAN computer programs designed for IBM systems, with versions converted for use on CDC systems also available. Detailed instructions for data coding are given, and small jobs can be sent (as punched data card decks) to the Patuxent Wildlife Research Center in Maryland for analysis and commentary at no charge. The loan of tapes can be requested by those wishing to obtain the programs, and they will be sent without charge to be copied and returned.

The authors strongly emphasize the need for advance planning of any study based on a thorough understanding of the methods and their assumptions. Chapter 8 summarizes analysis methods proposed by previous workers, and discusses interpretation of mark-recapture analysis results. Chapter 9 considers the planning of a study, including timing of sampling and necessary sample size. There is a comprehensive bibliography.

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The Gannet

By Bryan Nelson. 1978. Buteo Books, Vermillion, South Dakota. 336 pp., illus. U.S. $25.

It is obvious that Nelson has spent many hours watching Gannets. His readable style combines dry and factual with informal and anecdotal accounts. An incredible amount of detail is found throughout the book with emphasis placed on fact, integration, and interpretation. Nelson assures the reader that this book is not an extract of his recent monograph (*The Sulidae: Gannets and Boobies*. 1978. Oxford University Press. 1012 pp. U.S. $98) but has been written afresh and with a different approach.

The book is organized into seven chapters. Additional introductory and final sections include a preface, acknowledgments, a thumbnail sketch introduction, two pages on names, references, bibliographies, and an index. The 32 tables are grouped together and follow chapter 7. Major points are set out in numbered statements in a summary for each chapter. Numerous illustrations by John Busby are scattered throughout the book and are particularly valuable in the behavior chapter; a two and one-half page schematic representation of the Gannet's life history is especially nice. Black-and-white photographs covering 32 pages are located in the middle of the book. Although figures are numbered, the text often does not refer to them. The map numbers corresponding to the locations of the six Canadian gannetries in Figure 10 also do not correspond to the numbers in the text. In general a better correlation between text citations and figures, tables, and illustrations would have been an improvement.

Over 100 pages are devoted to breeding behavior and ecology where the author presents a myriad of interesting facts and ideas. An interpretation of the function and survival value of various behavioral traits is usually provided. The numbers and distribution chapter contains excellent sections on how, when, and what to count. Another interesting section discusses fishing techniques and includes quotes from Scottish fishermen.

Chapter 6 on the Gannet family and the order seems to come too late in the book. Chapter 7, on the other hand, is a perfect final chapter with subchapter headings on such fascinating topics as early accounts of the Gannet's natural history, its use as food, man's practice of culling in breeding colonies, oiled birds, its behavior in captivity, and its role in art and literature. I believe that those who read the book will find immense enjoyment. Buteo Books should be commended for publishing and making available several important avian works originally published in Europe.

NOEL J. CUTRIGHT

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BOTANY

Vascular Plant Families

By James Payne Smith, Jr. 1977. Mad River Press, Inc., Route 1, Box 151-B, Eureka, California 95501. 320 pp., illus. $9.55.

Students and teachers of plant taxonomy alike will welcome this elementary book which contains everything from an outline of the taxonomic hierarchy and scientific names, through family descriptions, lists of regional floras for the United States, notes on how to collect plants, to a useful glossary.

Following the system of Cronquist, Takhtajan, and Zimmerman (1966) for divisions, classes, subclasses and orders, and Cronquist (1968) for the sequence of families, the author presents "an introduction to the families of vascular plants native to North America, and selected families of ornamental or economic importance." This introduction consists of short descriptions of the families, an indication of the number of genera and species, a few selected genera, some recognition characters, and a floral formula. Over one hundred plates of fine line drawings by Kathy Simpson accompany this text. Of special interest to the student is the chapter entitled "Vegetative morphology of the flowering plants." This is an illustrated glossary which is divided into sections that give the terminology used to describe various parts of a plant and their arrangement, e.g., roots, stems, leaves, etc.

The book is written for students by a teacher who has tried to present his subject as simply as possible. The elimination of all but a few of the non-North American families has certainly made this easier. The author is to be congratulated on a job well done!

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An Atlas of Airborne Pollen Grains and Common Spores of Canada

By I. John Bassett, Clifford W. Crompton, and John A. Parmelee. 1978. Agriculture Canada, Ottawa. 350 pp., illus. $12 in Canada; $14.40 elsewhere.

This attractively and robustly bound research monograph represents the culmination of over two decades of careful, well reported investigations by the authors into the problems of airborne allergenic pollen and spores. It is addressed to workers who wish to identify airborne pollen and spores because of their interest in either allergy problems, or in general and applied palynology. Its effectiveness therefore should be measured by the clarity and quality of the illustrations; the rigor and decisiveness of the keys; and the degree to which it will become indispensable to the laboratory scientist in the appropriate disciplines. But its format implies a wider readership target.

The first 39 pages introduce the subject of allergy pollen. They vary from a few fascinating pages (15–16), to some dreary tables (16–39), which should be appendices. Pollen grains are exciting objects. A lively up-to-date chapter on their development, role in reproduction, life-cycle strategies, paleoenvironmental reconstructions, etc., as well as a more animated discussion of the intriguing material on p. 13 on diurnal patterns and the spectacular data on the decline of ragweed fallout since the 1950s might have captured a wider readership. And what about allergic reactions to pollen? Couldn't we have had a few pages summarizing the state of the medical arts on that?

We are plunged into the dichotomous identification keys to pollen, the heart of the book for the user. Presumably, the user will be the technician in the allergy laboratory, because other pollen work deals with ranges of material incompletely covered in this book.

Pollen keys at best are unsatisfactory and they are usually fully comprehensible and usable only by the authors themselves. The keys in this book are useful but uneven. For example, the distinctions between important species (*Fagus, Quercus*) are not clearly handled. *Comptonia peregrina* is not consistently tetraporate, as Figure 107 C and D demonstrate, and in fact is indistinguishable from *Myrica*. On the other hand *Alnus* could be separated readily to species, if it were useful to do so from the allergy viewpoint.

The photomicrographs are of very uneven quality. Some taxa have no light microscope photographs (*Carex*), others have interference and SEM but no non-interference light microscope illustrations though they are essential (e.g., *Fraxinus, Luzula, Triglochin, Zea,* and others). The magnification varies widely from plate to plate. And no attempt has been made to achieve uniformity of positioning of the grains in the SEM, photographs essential if they are to be used diagnostically. We are told that interference

photomicroscopy was employed because of its great use in such groups as *Urtica*. Possibly, but it is far from convincing that its use in most of the other groups illustrated adds anything to the book.

Part 2 deals with fungus spores, but it differs markedly from Part 1 in having no keys, in offering only a selection of representative types and illustrations, and in providing nothing more than a glossary to initiate the novice into the distinctive descriptive terminology of mycology. It creates the impression of being an afterthought.

This book will find its way into most North American pollen-spore labs, but whether it becomes dirty and dog-eared with use is another question.

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ENVIRONMENT

A Vanished World: the dinosaurs of western Canada

By Dale A. Russell. 1977. Natural History Series Number 4. National Museum of Natural Sciences, National Museums of Canada, Ottawa. 142 pp. $12.95.

In his introduction to *A Vanished World*, Dale Russell states that "The purpose of this volume is to visualize, so far as possible, the vanished world of Canadian dinosaurs . . . it is hoped that this work will help others to understand what western Canada may have been like during a very interesting and relatively well documented period of its physical history." Upon reading the book, one cannot help but conclude that in the short space of 142 pages, the author has managed to manifest successfully a most original approach to the study of the dinosaur era.

The book is filled with superb photographs (by Susanne M. Swibold) of the Canadian badlands, and of modern vegetation and habitats that compare closely with the projected environments of the Late Cretaceous in Canada. The photographs are complemented by equally striking artistic reconstructions (by Eleanor M. Kish) of many of the Canadian dinosaurs described in the text. All photographs and illustrations are in color.

The first chapter deals with the history of dinosaur collecting in western Canada, and as most published histories of palaeontology are concerned mainly or only with American localities and collectors, much of the material will be new to the general reader.

The second chapter provides a general survey of the geology of the Canadian badlands, with a brief insight into the methods of interpreting the prehistoric geography of an area from its sediments.

The third chapter describes Dinosaur Provincial Park in Alberta, an area of about 15000 acres of badlands containing exposed sediments that are from 76 to 73 million years old. At that time, Dinosaur Provincial Park was part of an ancient alluvial plain situated between the Rocky Mountains and the great inland sea which then covered much of the interior of the North American continent. Considering in turn the sediments themselves, then their plant, invertebrate, and vertebrate remains, the author logically and precisely reconstructs the environment of that period. A short section at the end of the chapter invites the reader to imagine himself back in those times and then to consider the possibility of his own survival under such conditions.

The fourth chapter treats the badlands around Drumheller, Alberta in a similar manner. The sediments of the Drumheller region contain fossil remains ranging from 72 to 70 million years in age. At that time, Drumheller was located on the southern edge of a large delta that extended more than 200 miles from the Rocky Mountains to the inland sea. The delta was "an enormous low-lying wetland of shallow lakes, swamps and marshes, traversed by streams that fanned out from the major river courses to the edges." Various aspects of the ecology of the delta are discussed, from the patterns of deposition of sediments to the vegetation and the dinosaurs that inhabited the area. Over a period of a few hundred thousand years, the ecosystem changed and the delta developed the characteristics of a coastal plain, as stream beds shifted and the swamps drained. The vegetation became markedly different from that of the wetland period, with forests of broad-leaved trees, many of which are familiar to us today. The kinds of dinosaurs inhabiting this drier, hardwood-forested area were somewhat different from those that lived in the swamps.

The fifth chapter takes us through the sediments of 70 to 65 million years ago into the geological period that signalled the end of the dinosaurs. The vegetation and the dinosaurs that lived on the large subtropical floodplain of this period are discussed. Because the floodplain extended into the United States, contemporary dinosaurs from Montana, Wyoming, and the Dakotas are also reviewed.

The last chapter considers the extinction of the dinosaurs. The final testimony of the late Cretaceous/Early Paleocene rocks is discussed, and various general aspects of the extinction problem are examined. In a concluding section, entitled "From the Depths of Space," the author takes the opportunity to elaborate upon the extinction theory he himself favors most: that of a cosmic event (probably a supernova) that bombarded the Earth with "waves of high-energy radiation comparable to those occurring near powerful thermonuclear explosions."

The bibliography, while comprehensive, is not overwhelming to the non-scientist, and many of the references are government publications which are reasonably accessible to the general public.

A Vanished World is written in a clear and logical style, and the ancient environments reconstructed from the rocks and their fossil remains become strong visual images within the mind of the reader. This book will be a valuable addition to the library of any person who has an interest in natural science.

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Biogeography and Ecology of Southern Africa

Edited by M. J. A. Werger. 1978. W. Junk, The Hague. xvi + 1439 pp., illus. (in 2 volumes). DFL 365.

Southern Africa as referred to in these two volumes covers an area of some 6100 000 km^2. The geopolitical areas included are: Angola, part of Shaba, Zambia, Malawi, Mozambique, South West Africa, Botswana, Rhodesia, South Africa, Swaziland, and Lesotho. Southern Africa varies in altitude from sea level to 3482 m and has a wide range of biotic and abiotic features.

There is an extensive published and unpublished literature on the biogeography and ecology of southern Africa. Much of this material appears in local journals, in various government reports, and as theses. As such it is not readily available to interested biogeographers and ecologists outside southern Africa. These volumes successfully review this large body of knowledge. As Werger points out, the ecological aspects covered are mainly of a descriptive nature, concentrating on diversity and variation in species and on a structural-functional evaluation; physiological aspects of the ecology, and energy and nutrient flow systems remain virtually untouched. Research in these latter fields has only recently started in southern Africa.

The two volumes are divided into 41 chapters. Approximately 75 percent of the contributing authors were living and working in South Africa when they wrote their chapters. Chapters 1 to 9 cover the physical and geological environment, past and present. Chapters 8 to 14 each deal with a major botanical biome while Chapters 16 to 31 each cover a major zoological taxonomic group. The next nine chapters deal with the biogeography and ecology of special habitats such as lakes, rivers, marine habitats, high termitaria, and heavy metal and other toxic soils. The final chapter discusses the conservation of southern African ecosystems. An extensive use of photographs and illustrations is made throughout the text. Typographical errors were few and the largest single printing mistake (Figure 9, Chapter 39) is corrected with an erratum.

A major pitfall of such reviews can be the length of time required to get them published. Although it is not possible to eliminate completely this lag phase, the publishers can do much to make it as short as possible, thereby increasing the value of the review. Dr. W. Junk, publishers, should be commended for the speed in which these two volumes were brought to press. References in the text date as recently as 1977.

Dr. Werger's contribution to the volumes as editor has been considerable. Throughout the text he has constructed a network of cross-references to earlier or later chapters in which additional information or a difference of interpretation can be found.

Unfortunately, in many chapters readers are referred to a specific geological formation or plant community located near a town not likely to be known beyond southern Africa or to individuals who have never lived there. A much greater use of maps such as Figure 1 in Chapters 30 and 38 would have been very useful.

Readers who have only a lay interest in the biogeography and ecology of southern Africa will find general information on many subjects concerning a most interesting part of the world. For example, in Chapter 16 we are informed that the world's largest earthworms, measuring 7 m in length by 7.5 cm in diameter, occur near Debe Nek in the Cape Province in South Africa and that some savanna areas have rodent populations that exceed those of the Brown Lemming in the tundra of Alaska at cycle peaks (Chapter 31).

These two volumes should attract many readers in academic or research institutions with an interest in Africa. Although, as Dr. Werger notes, the books are not all-encompassing (both in subject or in literature citations), they are an excellent source of information for any amateur or professional ecologist, naturalist, or biogeographer beginning a project on southern Africa. Purchase of these volumes by interested individuals, however, is unlikely since the approximate Canadian price of $200 will be prohibitive in most cases.

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The Ecology of North America

By V. E. Shelford. 1978. University of Illinois Press, Urbana. Paperback edition, originally published 1963. 610 pp., illus. No price given.

This book was first published in 1963, and is now resurrected in paperback form. Undoubtedly an important contribution to ecology in its time, the purpose of the book is ". . . to describe North America from an ecological viewpoint as it appeared in the period A.D. 1500 to 1600 before European settlement."

Taking over half a century to complete, Shelford undertook the monumental task of reconstructing the ecological story of primeval North America using results from his own studies, those of his students and his colleagues. This book is designed to assist the ecologist in understanding the habits, biotic communities, and the distribution and abundance of plants and animals in primeval North America. To this end, Shelford focuses on the biogeographical aspects of primeval ecology.

The text is organized into 19 chapters. The first chapter reviews the meaning of major underlying ecological principles. Among them are habitat, community, dominance, community development, population densities and distribution, life span, life cycles, solar radiation, temperature and moisture, natural communities of North America, and community terminology. Many of these principles continue to form the underlying components of modern ecology; however, a decade and a half of research and development has improved and expanded our knowledge of them. In this regard it is important that the reader be aware of these changes.

The following 18 chapters cover all of the major communities in North America, from the high Arctic to southern Florida and Cuba.

Shelford not only attempts to document the abiotic and biotic components of each community, he attempts to interrelate these components and develop a comprehensive review of the mechanics of the natural systems in primeval times. Despite his valiant attempts to do this there are inherent defects. The interrelationships of animals and plants were not well understood during Shelford's time and consequently are poorly documented. In addition, the book fails to present quantitative data on animal populations and their food habits, and plant population dynamics.

The book is accented with maps, graphs, tables and photographs. The references are extensive, and are useful to those who wish to examine some of the earlier works in ecology.

I recommend this book to biologists who are well read in general ecology and who are capable of recognizing its inadequacies.

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Chlorinated Phenoxy Acids and their Dioxins

Edited by C. Ramel. 1978. Ecological Bulletins Number 27, Swedish Natural Sciences Research Council (NFR), Stockholm, Sweden. 302 pp. 75 SwCr.

This bulletin is a collection of papers from a conference arranged by the Royal Swedish Academy of Sciences in Stockholm, 7–9 February 1977. The intent of the symposium was to provide an up-to-date summary of objective scientific data on chlorinated phenoxy acids and their dioxins, and to make a risk-benefit evaluation of this data in a series of work groups in the areas of chemistry, plant physiology, toxicology, genetics, and ecology with economics. A group of 35 internationally recognized experts participated in the symposium. Unlike so many scientific symposia, this one was results-oriented. Summary papers with recommendations were prepared by each of the working groups. All of the background papers and summaries are given, along with a short overall conclusions and recommendations section.

The chemistry section and a considerable propor-

tion of the toxicology section are devoted principally to tetrachlorodibenzo-p-dioxin, the notorious TCDD. TCDD is an incidental contaminant formed during the manufacture of trichlorophenol, which in turn is a precursor of the herbicides 2,4,5-T and 2,4,5-TP (fenoprop). The bulletin gives an interesting account of the toxicological problems (real or imagined) from phenoxy acid (largely 2,4-D) use in Sweden. One of the more controversial aspects was the suspected poisoning of a reindeer herd in 1970. The veracity of other alleged cases of poisoning of humans, wildlife, fish, and bees are discussed in some detail. In the section on ecology and economics there is a thorough coverage of the effects of herbicide use in silviculture on vegetation, but not much information is given on how these effects relate to animal or insect ecology (i.e., habitat changes), in spite of the title. The importance of this subject is recognized, however, in the summary and recommendations. A good review of the effect of phenoxy herbicides on soil organisms is given.

According to the National Research Council of Canada document on the same subject (Phenoxy Herbicides, their Effects on Environmental Quality, NRCC Number 16075), several million kilograms of 2,4-D are used in Canada, largely for weed control in the prairies. In the order of 50,000 kilograms (1973–1974) of 2,4,5-T are used for brush control on rights-of-way, mainly in the eastern provinces. This bulletin therefore addresses a situation in Canada of similar magnitude and import to that in Sweden. Although there are gaps in coverage (in large part due to a lack of information, I suspect), this volume is one of the best overall sources of information available on the subject. The many sections on TCDD have relevance apart from phenoxy herbicides, because trichlorophenol manufacture and dumping have created more TCDD problems than 2,4,5-T use. The summaries and recommendations are succinct and well-balanced from an overall risk-benefit viewpoint.

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MISCELLANEOUS

Last of the Naturalists: the career of C. Hart Merriam

By Keir B. Sterling. 1977. Arno Press, New York. 472 pp., illus. U.S. $23.00.

This book should be perused by those interested in the formation and early activities of the American Ornithologists Union, National Geographic Society, American Society of Mammalogists, and U.S. Fish and Wildlife Service, all of which Merriam (1855–1942) was directly involved in founding.

Sterling has exhaustively researched the life of Merriam using file letters to and from Merriam, congressional documents where Merriam participated, journal and newspaper articles, interviews with people who knew him, and other detailed records to produce a fine biographical work that doesn't stop with information on Merriam but includes personalities of people that were around him.

This revised book, first issued in 1974, is part of the *Natural Sciences in America* collection. The text is cluttered with quite a few typographical errors: entire words and even sentences seem to be missing in some spots. The chapter on speciation is poorly written. As well, errant definitions occur, such as Bergmann's rule (p. 205). The Elliott Coues – Merriam vendettas are probably not fully covered. Perhaps a better title would be The First American Wildlife Biologist or Mammalogist, as the book's present title implies that the Leopolds and Muries were not naturalists.

Merriam's career included being an amateur naturalist, a medical school graduate, practicing physician and professional biologist with the government. He worked under the vigilance and influence of Joel A. Allen, Spencer F. Baird, Jean B. Lamarck, Charles V. Riley, and Theodore Roosevelt. He influenced the professional lives of Vernon Bailey, William Brewster, Frank M. Chapman, Albert K. Fisher, Joseph Grinnell, Francis Harper, Henry W. Henshaw, Waldo L. McAtee, Edward W. Nelson, and Wilfred Osgood, many of whom worked for the U.S. Biological Survey under his leadership.

Merriam was highly interested in the biogeography and systematics of mammals and birds (he collected thousands of specimens); published his first paper at age 17, became an authority on birds at 22; was the United States' first full-time professional ornithologist; did not "follow the herd"; scorned religion; liked to eat meat of cat, eagle, and skunk; had yearly field experience throughout his life; believed that species were basically fixed but all were not yet discovered; named and described many new genera, species, and subspecies, being a splitter when it came to zoological

nomenclature; put forth the life-zone theory, feeling that temperature was the ultimate factor affecting the distribution of plants and animals; worked intensively with gophers and bears; thought life was too short for memorizing terminology, believing that practical application was pertinent to all work; felt that microscopic work in the laboratory was emphasized too much over field work in college; did not get along with others whose drives were as great as his; was involved in the still controversial killing of seals in the north; could not receive criticism well; tried to get deer farming initiated in areas where cows could not graze; liked art and automobiles; despised the words biota and ecology; was against conservation movements that were not scientifically based; had a special ability to obtain capable men to work for him at the Biological Survey; served office in many scientific societies; was most particular about the proper preparation of skins and skulls; became interested in Indians in the early 1900s, mostly ignoring or even terming as useless most other mammals for the remainder of his life; later in life turned against the Biological Survey's predator poisoning campaign which he started; was never considered an intellectual; and never accepted the developments that progressed in genetics. He was the father of modern Mammalogy.

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Le Naturaliste Canadien, Index

By G.-W. Corrivault and P. Morisset. 1979. Les Presses de l'Université Laval, Québec. 352 pp. $10.

Readers of *The Canadian Field-Naturalist* are familiar with the problems of data retrieval from a long series of volumes. The search for specific data through so many annual indices is not only tedious, it may also be a poor use of one's time. Because annual indices are not equally thorough and comprehensive, some being rather skimpy, one is never sure that significant data has not escaped such a search. Cumulative indices are the usual solution to these problems, but not every journal has been able to prepare and publish these.

Le Naturaliste Canadien is now in its 105th volume and its data retrieval problems are quite similar to those of *The Canadian Field-Naturalist,* except for the existence of a series of cumulative indices of which the present one is the fourth. A cumulative index covering the first 20 volumes was published at the end of volume 20. A second cumulation was printed at the end of volume 54 and covers volumes 21–54. A cumulated author index for volumes 1–81 will be found at the beginning of volume 82.

The new cumulation carries the coverage forward to volume 100. It is a separate publication, not a particular issue of the serial. It is published in two parts. The first part is an alphabetized author index of 2504 papers found in volumes 1 to 100. By design the author index is not thorough: many minor items of fleeting value have been omitted, such as notices from the editor to his readers, some letters to the editor, society notices, and the like.

The second part deals only with volumes 55 to 100. It is a subject and taxon index with double references. The bracketed numbers refer to the bibliography and are followed by the usual volume and page references. There are more than 60 000 individual entries.

Botanists will be especially interested by this index. There is very little botany in the first 50 volumes of *Le Naturaliste Canadien.* But in the 1920s and 1930s botanical papers gradually gained in numbers and import. More than 8000 plant names occur in the index, including nearly all the vascular plants of Canada, Greenland, and Alaska; also a majority of Canadian mosses and lichens, and a fair showing of algae and fungi.

Taxonomic innovations are underlined in the index: there are more than a thousand of them and a good half of them are plant names.

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NEW TITLES

Zoology

The alligator: king of the wilderness. 1977. By William and Ellen Hartley. Nelson, New York. 175 pp. US $7.95.

†**Animal behavior: an evolutionary approach.** 1979. By John Alcock. Second edition. Sinaver, Concord, Maine. xii + 532 pp., illus. US $16.

Animals of the oceans: the ecology of marine life. 1977. By M. Angel and T. Harris. Two Continents, New York. 156 pp., illus. US $10.95.

Arachnology. 1978. Edited by P. Merrett. Proceedings of the Symposia of the Zoological Society of London, Number 42, Exeter, England, July 1977. Academic, New York. xxxii + 530 pp., illus. US $46.50.

Eloquent animals: a study in animal communication. 1978. By Flora Davis. Coward, McCann, and Geoghegan, New York. 223 pp. US $8.95.

Field guide to seashells of the world. 1978. By Gert Lindner. Van Nostrand Reinhold, New York. 271 pp., illus. Cloth US $12.95; paper US $8.95.

Fifty common birds of Oklahoma and the south great plains. 1977. By G.M. Sutton. University of Oklahoma Press, Norman. xii + 113 pp. US $7.95.

Insect magic. 1978. By Kjell B. Sandved and Michael G. Emsley. Viking, New York. 128 pp., illus. US $16.95.

†**Management and biology of Pacific flyway geese.** 1979. Edited by Robert L. Jarvis and James C. Bartonek. Oregon State University Book Stores, Corvallis, Oregon. 346 pp., illus. Paper US $5.50.

Primates of South Asia: ecology, sociobiology and behavior. 1977. By M.L. Roonwal and S.M. Mohnot. Harvard University Press, Cambridge, Massachusetts. xx + 421 pp., illus. US $25.

Responses of Peary Caribou and Muskoxen to helicopter harassment. 1979. By Frank L. Miller and Anne Gunn. Occasional Paper Number 40, Canadian Wildlife Service, Edmonton. 90 pp. Free.

Sea squirts of the Atlantic continental shelf from Maine to Texas. 1979. By Harold H. Plough. Johns Hopkins University Press, Baltimore. ix + 118 pp., illus. US $20.

†**Studies on Atlantic halocyprid ostracods.** 1979. By Martin V. Angel. Pergamon Press, Elmsford, New York. 128 pp., illus. US $27.50.

The vertebrates: their forms and functions. 1978. By Charles G. Crispens, Jr. Thomas, Springfield, Illinois. x + 209 pp., illus. US $15.50.

Water birds of California. 1977. By Howard L. Cogswell. University of California Press, Berkeley. vi + 399 pp., illus. US $5.75.

*__Wolf ecology and prey relationships on Isle Royale.__ 1978. By Rolf Olin Peterson. National Park Service Scientific Monograph Series Number 11, United States Department of the Interior, Washington. 211 pp. Paper.

The world of worms. 1978. By Dorothy Hinshaw Patent. Holiday House, New York. ii + 124 pp., illus. US $6.95.

Botany

Botany: basic concepts in plant biology. 1978. By Terry L. Hufford. Harper and Row, New York. xviii + 535 pp., illus. US $16.95.

Essays in plant taxonomy. 1978. Edited by H.E. Street. Academic Press, New York. 304 pp. US $24.50.

*__A guide to the literature on the herbaceous vascular flora of Ontario.__ 1978. By James L. Hodgins. Revised edition. Botany Press, 90 Wolfrey Avenue, Toronto. 73 pp. Paper $4.

*__How to prepare common wild foods.__ 1978. By Darcy Williamson. D. Williamson, Box 1032, McCall, Idaho 83638. 110 pp., illus. Paper US $6.95.

Introduction to the algae: structure and reproduction. 1978. By Harold C. Bold and Michael J. Wynne. Prentice-Hall, Englewood Cliffs, New Jersey. xiv + 706 pp., illus. US $24.

The physiology of woody plants. 1979. By Paul J. Kramer and Theodore T. Kozlowski. Academic Press, New York.

Plant strategies and vegetation processes. 1979. By J.P. Grime. Wiley-Interscience, New York. 264 pp. Cloth US $26.50; paper US $10.95.

Plantcraft: a guide to the everyday use of wild plants. 1978. By Richard Mabey. Illustrated by Marjorie Blamey. Universe, New York. 176 pp., illus. US $10.

The powdery mildews. 1978. Edited by D.M. Spencer. Academic Press, New York. 586 pp. US $54.75.

†**The rare vascular plants of Saskatchewan.** 1979. By Robert V. Maher, George W. Argus, Vernon L. Harms, and John H. Hudson. Syllogeus Number 20. National Museum of Natural Science, Ottawa. 55 pp. + maps English + 55 pp. French. Free.

River plants: the macrophytic vegetation of watercourses. 1978. By S.M. Haslam. Illustrated by P.A. Wolseley. Cambridge University Press, New York. xii + 396 pp., illus. Cloth US $62.50; paper US $14.95.

Vegetation and production ecology of an Alaska arctic tundra. 1978. Edited by L.L. Tieszen. Springer-Verlag, New York. xviii + 217 pp., illus. US $34.80.

Environment

Adaptive environmental assessment and management. 1978. Edited by C.S. Holling. IIASA International Series on Applied Systems Analysis, 3. Wiley-Interscience, New York. xx + 378 pp., illus. US $16.50.

*__Aleta Karstad's Canadian nature notebook.__ 1979. By Aleta Karstad. McGraw-Hill Ryerson, Toronto. 144 pp., illus. $12.95.

Biology and ethics: reflections inspired by a UNESCO symposium. 1978. By Bruno Ribes. UNESCO (Canadian distributor Renouf Publishing, Montreal). 202 pp. $14.

Coral reefs: research methods. 1978. Edited by D.R. Stoddart and R.E. Johannes. Monographs on Oceanographic Methodology, 5. UNESCO (Canadian distributor Renouf Publishing, Montreal). xv + 581 pp. $33.60.

The ecology of fossils: an illustrated guide. 1978. Edited by W.S. McKerrow. MIT Press, Cambridge, Massachusetts. 384 pp., illus. US $22.50.

Environmental assessment: approaching maturity. 1978. By Selina Bendix and Herbert R. Graham. Ann Arbor Science, Ann Arbor, Michigan. xiii + 288 pp. US $20.

The environmental impact statement process: a guide to citizen action. 1978. By Neil Orloff. Information Resources Press, Washington. 200 pp. US $10.95.

Exploring nature with your child. 1977. By Dorothy Shuttlesworth. Abrams, New York. 240 pp., illus. US $18.50.

Freshwater wetlands: ecological processes and management potential. 1978. Edited by Ralph E. Good, Dennis F. Whigham, and Robert L. Simpson. Academic Press, New York. 392 pp. US $17.50.

Handbook of environmental data and ecological parameters. 1979. Edited by S.E. Jorgensen. Pergamon Press, Elmsford, New York. 1100 pp. US $150.

Handbook of environmental data on organic chemicals. 1977. By Karel Verschueren. Van Nostrand Reinhold, New York. vi + 659 pp. US $37.50.

An introduction to population ecology. 1978. By G. Evelyn Hutchinson. Yale University Press, New Haven. xi + 260 pp. US $17.50.

Investigating ecology. 1978. By E.H. Blaustein and R. Blaustein. Arco, New York. 140 pp. Cloth US $11.95; paper US $7.95.

Key works to the fauna and flora of the British Isles and northwest Europe. 1978. Edited by G.J. Kenrich, D.L. Hawksworth, and R. Sims. Academic Press, New York. 192 pp. US $16.15.

Marine biota of the NE Pacific: a bibliography emphasizing systematics and distribution. 1978. By W.C. Austin and M.M. Deutsch. Khoyatan Marine Laboratory, Cowichan Station, British Columbia. Variously paged. Paper $16.

Oceanography: concepts and history. 1978. Edited by Margaret B. Deacon. Benchmark Papers in Geology, Volume 35. Dowden, Hutchinson, and Ross (Distributed by Academic Press, New York). 416 pp. US $25.

The pollution of flowers by insects. 1978. Edited by A.J. Richards. Academic Press, New York. 262 pp. US $26.

Sampling design and statistical methods for environmental biologists. 1979. By Roger H. Green. Wiley-Interscience, New York. 272 pp. US $19.95.

Tropical forest ecosystems: a state of knowledge report. By UNESCO, UNEP, and FAO. Natural Resources Research, XIV. UNESCO (Canadian distributor Renouf Publishing, Montreal). 683 pp. Paper $53.50; cloth $66.50.

Miscellaneous

Suicide or survival? The challenge of the year 2000. 1978. Various authors. UNESCO (Canadian distributor Renouf Publishing, Montreal). 192 pp. $14.

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Erratum

Canadian Field-Naturalist 93(3): 232–238; 1979.
Seasonal growth, food, and feeding habits of young-of-the-year Black Crappie in the Ottawa River by John Mark Hanson and S. U. Qadri.

The $\log_{10}$ values for total length given on the X-axis of Figure 4 are incorrect; they should be 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, and 2.0.

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